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Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART I, 1950

The Use of Statistics in Business

[The Inaugural Address of the President, Sir Geoffrey Heyworth, delivered to the Royal Statistical Society on October 31st, 1949]

I do not want to talk to-night about theory, both because I am not a professional statistician, and because on the whole the figures a business man requires are usually sufficiently simple for him not to need to concern himself with theory. He does not create theory; as to all the other generalizations aries are so dependent on theory to its development.

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This close connection between figures and the action which follows on them distinguishes business statistics very clearly from those of a research body and from most of the statistics published by the government. They publish their figures for general use. They, therefore, have to be able to stand up to the scrutiny of a wide public who may criticize them from many different points of view, and who may use them for purposes in which very different margins of error are tolerable. They have, therefore, to be accurate, or if they are not accurate, this fact has to be made quite clear to the reader; they have also to be free of avoidable ambiguity. Finally, they have to recognize that most of the people who read them do so only to provide themselves with a background of general knowledge. They often do not propose to do anything at all, and they very rarely propose to do anything immediate, as a result of what they learn. Let me take as an example the figures of marriages published by the Registrar-General. Obviously these can and should be exact. Nobody would be satisfied with being told that there were roughly 300,000 marriages this year against approximately 250,000 last year. They are figures also for which everybody is content to wait. The exact answer in the middle of July is preferred to an approximate answer on the 2nd of January. Finally, they are figures which are very widely read, but which most people read purely for interest, and even in the case of the minority who do draw some deduction from them, the Registrar-General does not normally present his figures in a way which will make it easier for them to reach their conclusion; he cannot, because he does not even know what *sort* of conclusions they are trying to reach, and because, if he tailored his figures in a way that was suitable for, say, the housing planner, they might be of no help to, say, the population expert.

ERRATA

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.ge 438, Table 2 C. Insert 437 as page reference.

age 442, Table 10.

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age 443, footnote. *For Table* 9 *read Table* 11.

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I do not want to talk to-night about theory, both because I am not a professional statistician, and because on the whole the figures a business man requires are usually sufficiently simple for him not to need to concern himself with the refinements of theory. He does not create theory; he merely uses it, though there are, of course, exceptions to this as to all the other generalizations I am going to make. Market researchers or life insurance actuaries are so dependent on theory that they may well be able to make considerable contributions to its development.

The reason why the business man is not much interested in theory is that he wants figures, not for the advancement of knowledge or for their scientific interest, but only as a help in deciding what he ought to do next in the running of his affairs, and it is this fact which lies behind all the points I hope to make this evening. They are three. First, that business statistics have to be simple; second, that they should be made available in any business only to those who can take useful action on the basis of them and not to everybody who may be interested in them; and, third, that they are useful only as a check on, not a substitute for, the business man's judgment. All three follow from the proposition that the primary purpose of business figures is to provide information on which the business can make its decisions. When a business man uses his figures for a theoretical purpose, he has, for the time being, ceased to be a business man and become an economist.

This close connection between figures and the action which follows on them distinguishes business statistics very clearly from those of a research body and from most of the statistics published by the government. They publish their figures for general use. They, therefore, have to be able to stand up to the scrutiny of a wide public who may criticize them from many different points of view, and who may use them for purposes in which very different margins of error are tolerable. They have, therefore, to be accurate, or if they are not accurate, this fact has to be made quite clear to the reader; they have also to be free of avoidable ambiguity. Finally, they have to recognize that most of the people who read them do so only to provide themselves with a background of general knowledge. They often do not propose to do anything at all, and they very rarely propose to do anything immediate, as a result of what they learn. Let me take as an example the figures of marriages published by the Registrar-General. Obviously these can and should be exact. Nobody would be satisfied with being told that there were roughly 300,000 marriages this year against approximately 250,000 last year. They are figures also for which everybody is content to wait. The exact answer in the middle of July is preferred to an approximate answer on the 2nd of January. Finally, they are figures which are very widely read, but which most people read purely for interest, and even in the case of the minority who do draw some deduction from them, the Registrar-General does not normally present his figures in a way which will make it easier for them to reach their conclusion; he cannot, because he does not even know what *sort* of conclusions they are trying to reach, and because, if he tailored his figures in a way that was suitable for, say, the housing planner, they might be of no help to, say, the population expert.

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It is quite different in business. I do not, of course, claim that there are no figures produced in a business organization whose only value is their interest. There is an inertia which makes people go on producing figures long after they can be of any use as a guide to action, simply because everybody has got accustomed to seeing them, and would feel rather lost without them. But in a business such figures are not to be encouraged, but to be guarded against as the besetting sin of one's Statistical Department. Every figure which is produced costs money. Every figure, therefore, which performs no positive function lowers the productivity of one's organization.

A few examples of the sort of figures which we collect in our own organization will make my point clear. Since our object in life is to provide the community with certain commodities of which they stand in need, mainly, as you know, soap and margarine, we obviously must know just how much we are in fact selling. So we have weekly sales summaries for detergents, toilet preparations, edible fats and foods for every area and country and for every brand and type. But it is not enough for us merely to know that we have in a given period sold a given quantity. We want to know also whether the business is going forward or going back. So we have comparative figures to show how this year's performance compares with last year's, and how it compares with what we put down in our budget before the year began that we thought we ought to sell.

We are not only a selling organization—we also manufacture. We therefore have to have adequate figures of what it costs us to produce any given line. Obviously, without such figures, it would be difficult to fix a proper selling price, or to say whether our factories are running as efficiently as they should. So we keep elaborate records of prices of raw materials, of wages and administrative salaries, of the use of steam and power, of absenteeism percentages and so on. We require, too, to get an idea periodically of the position of the business as a whole and how it is doing, so we have not only our annual balance-sheet and profit and loss account, but also estimates made at more frequent intervals or to cover shorter periods.

We also have an interest in statistics of a more general nature. We operate in most of the countries of the world. We frequently have to decide whether it would be, say, a better proposition to erect a new factory in Malaya or to extend our ice-cream business in England. To come to a satisfactory decision we have to know all about not only the specific conditions of the trade in which we are proposing to engage in Malaya and England, but also the whole general health of their economies, since our chance of expansion and our risk of having our investment confiscated are both to a quite considerable extent outside our control, because they are dependent on general conditions in the country. So for such purposes a whole range of outside statistics may be relevant, from the amount of debt in the countryside to the number of votes obtained by Communists in municipal elections.

As you will see, taking the business as a whole we use a very wide range of figures indeed. Since people's capacity to absorb figures varies a great deal, and since the way in which they use figures, the precision they demand of figures and the sort of figures they consider relevant, vary even more, it is necessary in our business, as in any other, to tailor our statistics to the minds of the people who are going to use them. The trained accountant will very often feel unhappy unless his figures have the exactness recommended by the Council of his Institute, even though in some particular cases this may be a higher level of precision than is actually required. Another man likes to know only the broad picture and not to be bothered with details, or perhaps simply appreciates that figures cannot be more accurate than the underlying data on which they are based. If one measures the contents of a tank of oil by using a staff which can only measure to within 2 per cent., it is clearly no use getting the final answer down to three places of decimals. So when one changes either the person who receives the figures or the accountant who produces them, one has very often to change also the form of the figures and sometimes their content also to suit the mental approach of the new incumbent; though, of course, the needs of continuity impose a limit on the severity of the changes which can be made.

An even more important consequence of the function of business statistics as a foundation for business decision is the need in any business to decide very carefully to whom any particular set of figures shall be shown. In a large business, if all the figures are circulated to everybody, either they would never get read at all, or else nobody would have the time to do any other work at all. It is therefore necessary to make sure that the figures should go only to the people who are immediately concerned in correcting any defects they may reveal, or in making the judgments for which they provide some of the material. They can never provide the whole of the material because

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judgment has to be governed also by instinct and by knowledge. The statistics themselves are meaningless unless one has both personal knowledge of the people and the things to which they refer, and a feeling for the whole situation of which they are trying to measure a few possibly unrelated parts. It is, therefore, for example, specially important that detailed figures should not go too high up, because when they do, lack of this knowledge and this feeling leads to far too many questions being asked. Since business figures can only be a shorthand giving indications of what is happening, not the full picture, they can only be properly interpreted by somebody who is in daily contact with what lies behind them and so therefore is in a position to fill in the missing background. Too many figures complicate judgment even more than too few. I can give you one simple example. In every factory one keeps records of machine performance, that is of the time during which each machine has actually worked as against the maximum time for which it could efficiently have been worked. Now, to the foreman of any particular shop these figures are very valuable, because he knows automatically all the obvious explanations for any falling short they may bring to light. If he has a figure of 50 per cent. and he knows that the machine was under repair for half the week, then he gives it no further thought. If he has a figure of 90 per cent. and he had expected one of 95 per cent., then he begins to investigate to find out where the minor inefficiency is that he has overlooked. But if one sends these same figures up to the Chairman, then he will probably not question the 90 per cent., which on the face of it looks all right, but he will clearly want to know the reason for the 50 per cent., the simple and obvious explanation for which is not known to him. One of my own tests of efficiency, therefore, when inspecting a unit is to look and see where the statistics are kept. Drawers full of figures and walls full of charts in a manager's office are a certain sign of something wrong, of an attempt to do by reading what can only be done effectively by going and looking. A few simple figures in each section of the works, giving just the information a particular supervisor requires in order to look after his own job properly are, on the other hand, a very considerable indication that the unit is being conducted properly.

It is not only important that the figures should go only to the right people if proper conclusions are to be deduced from them; it is also important that they should come at the right time. It is no use knowing in June that one's stocks were very high in December. If one's stocks are to be kept at a proper level, then one must know all the time how big they are. Speed is far more important than exact accuracy. If in the condition of to-day's markets my stocks ought to be 50,000 tons, and I am told they are approximately 80,000 tons, I can take immediate action, and it will not matter even if the figure of 80,000 was a thousand too high or a thousand too low. But if the accounts department takes six weeks in checking and calculating in order to be able to tell me that the exact figure is 80,159·65 tons, the figure may well be of no use to me at all. I may have lost an opportunity of unloading my surplus stocks at a suitable price, or I may have already bought more stocks during that six weeks, or I may feel that during the interval the position has corrected itself—though any such feeling could itself only be a guess, because it would presumably take another six weeks to confirm it.

The sort of figures one collects in a business, the accuracy one demands and the circulation which one gives them all depend, therefore, upon the one crucial test. The figures are there, not for their intrinsic interest, but only to provide a basis for decision. The figures can only provide facts on which judgment is exercised. They cannot replace judgment. Indeed, without a business man's own knowledge and experience the figures are frequently meaningless and almost always misleading. For instance, one's sales returns may tell one that one has sold less margarine in France this year than last, but to interpret those figures one has to use one's own knowledge of whether one's French sales management is not as good as it used to be, or whether there has just been a glut of butter in the French market. The value of the figures is that they put one on guard that there is a problem to which one's knowledge has to be applied. Again, one unit may show a much higher absentee rate than another, but that alone does not prove that the unit with the higher rate has the worse labour relations. The answer—an answer the figures will not give—may be that the operations of the unit with the worse record are seasonal, or that it employs a large proportion of married women, or that it is in an area where labour is particularly scarce. This necessity to import one's own knowledge into the figures before one can arrive at a satisfactory judgment is true of even the simplest cases. One salesman may show persistently lower sales than another, yet the answer may be not that he is less competent, but that the area he serves

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is poorer, or that one's product sells best in towns whose water is hard and the area he serves has soft water. Such facts cannot be put down as notes on the statistical sheets; it would take too long.

The test of the proper use of business statistics, therefore, is always the skill with which the user combines his own knowledge with the raw figures to produce the finished judgment. There is no substitute for managerial judgment. All statistics can do is to reduce the chance of error inherent in managerial ignorance or managerial prejudice. The best example is market research, which has developed very greatly in the last twenty years and has now reached a stage where, if the questions to be asked are sufficiently expertly framed, the answers obtained will give one a reasonably accurate reflection of the public state of mind. One can thus learn that 70 per cent. of housewives buy their toothpaste for the flavour, or that some other percentage do not notice a difference in price of ½d. on soap powder. But this widening of the range within which definite facts can be obtained makes the task of judgment more, not less, difficult. In the old days one knew simply that lower prices normally meant bigger sales. So elementary a fact could produce only the quick and elementary judgment that price-cutting was an effective form of competition. The more extensive the information one has about how exactly price cuts affect the public's mind, and their willingness to buy more of one's own product against those of one's competitors or against alternative ways of using their money, the more delicate becomes the problem of judgment on how far the public will, in fact, act in accordance with its expressed intentions, of how far one's competitors have similar information which will encourage them to take parallel and perhaps frustrating action, and of how far other trades may react to one's own actions. The more facts one has, the better the judgment one can make, but one must never forget the corollary that the more facts one has, the easier it is to put them together wrong.

The supreme instance of the use of judgment in business is when one enters upon new capital expenditure. The factory one builds to-day has to pay for itself over a generation. One's action in building it, therefore, involves a whole series of calculations about the future, and since there are no future facts but only "guesstimates," capital expenditure has to be based on crystal gazing. The final test of one's judgment is how deeply one can gaze.

In this sphere one's judgment is bound to be based primarily on experience and instinct. If one has known a trade for one generation, one is likely to have in one's bones a feeling about how it is likely to go in the next generation. In a rapidly changing world, however, past experience can be most misleading. Both the period immediately after 1918 and the last few years have provided excellent examples of this. For instance, in the period of full employment since 1945 people have often behaved as if the unemployment of the '30's was the great immediate menace, and in the early 1920s we over-deflated because bankers were able to think only in terms of the pre-1913 Gold Standard, the conditions for whose proper functioning no longer existed. There is, therefore, no excuse for not checking, so far as one can, the validity of one's intuitions. Population figures tell one something. Obviously an increasing population, other things being equal, means an increasing market. Productivity figures tell one rather more. A country where productivity per head is increasing is a country where the ordinary man is getting richer. Social surveys in conjunction with one's own sales statistics may tell one more still. The sale of potatoes goes down with increasing wealth—that of soap goes up. The balance of payments may be relevant. If walnut can only be bought with dollars and if one can see that England will be short of dollars for years to come, it may be worth while investing money to develop sterling mahogany. Politics can be important. If one is considering investing abroad, the percentage one has to obtain on one's money is obviously very much higher in a country on the verge of revolution than it is in one with the social stability of Switzerland, and figures about distribution of income or peasant indebtedness are of considerable value in telling one which countries are likely to be permanently unstable.

There is, indeed, almost no end to the statistics which may be relevant in that consideration of the middle future which is the necessary preliminary of all capital expenditure. But here, again, one cannot lay down by rule exactly which statistics should be used in any particular case. It is a judgment of possibilities which has to be formulated, and each man will formulate it in his own way and make his own selection from the facts. The figures are only crutches to assist where one's experience or one's instinct goes lame, and one man's lameness would be another man's strength. No given set of figures, for example, can be used as an index of political instability.

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One man may place importance on the numbers detained without trial, another on the size of peasant rents, and a third on the proportion of industrial workers in the population. Even in very much simpler examples no one set of figures can be laid down as obligatory material for one's judgment. One man may feel that an increased population will inevitably mean an increased sale for his product—all he needs is a population projection. Another may feel that as the country gets wealthier there will be a change in the amounts the average man will use—he will want figures on productivity and income distribution. Yet another may feel that the country's position is such that it is likely to get poorer rather than richer—he will want figures on exports and capital investment and savings. The possibilities are infinite and obviously one cannot have figures to cover them all; even if one could, one would not have the time to read and study them all. One always has in one's mind a general idea of the shape of the future. One uses figures only to make that idea more precise, and to show whether or not it is generally defensible. To nearly all of them one has to apply the special quality of mind which picks out the relevant from the irrelevant, and the special experience which tells one how one set of facts modifies another to which it may be apparently unrelated. One begins with a judgment and one ends with a judgment. The purpose of figures is to come in the middle in order to make the judgment with which one ends more accurate than the one with which one began.

Proceedings of the Meeting

Dr. David Heron (Preceding President): It is the privilege of the immediate Past President to welcome the incoming President at his first appearance at an Ordinary General Meeting and to move the vote of thanks for his inaugural address, and I do so with the greatest pleasure. As most of you know, our Presidents fall into two groups, first, the internal Presidents, who need not be further described, and certainly not by me, and secondly, the external Presidents, who are always men of the highest eminence in public affairs, but who usually have not been very closely associated with the work of the Society. For this session it was the turn for an external President, and we are very happy that we were able to induce Sir Geoffrey Heyworth to accept this office. Sir Geoffrey is not only the head of one of the largest and most successful commercial organizations in the world to-day, but amongst his other interests he is Chairman of the Advisory Council of the Department of Scientific and Industrial Research, and I feel that no better qualifications can be called for in our President. We realize fully that there are very heavy demands on his time and energy, but I can assure him that the other Honorary Officers and the members of the Council and the staff of the Society will do everything in their power to make his task as easy as possible. I hope he will have pleasure in his Presidential duties, and that when his term of office comes to an end he will be able to retain for many years his interest in the Society.

It is a long-standing practice of the Society that the President's inaugural address is immune from the usual spirited criticism and discussion. That need not be too closely followed, but I can at least commend it for its brevity and concentration. If some of the Fellows who read papers at our meetings would imitate him, the effect on the finances of the Society would be very satisfactory. I do not propose to make any detailed comment on the paper, because I shall be followed by those who can do so more effectively, but I found his address most stimulating. It shows that if any organization, particularly a world-wide organization such as his, is to be carried on satisfactorily, there must be the highest degree of efficiency in every department, and not least in the Statistical Department.

I move a cordial vote of thanks to Sir Geoffrey Heyworth for his inaugural address.

Lord Woolton: It is the privilege of the last President but one to second this vote of thanks, and I may tell you, Sir Geoffrey, that I was the last person the Society elected to the chair who knew nothing about the subject. We congratulate ourselves on having you as the President, and if you get as much pleasure out of the occupancy of that chair as I did two years ago you will be very glad indeed that you came to it.

You have given us a fleeting glance over a very wide range of statistical information; you have brought before us a wealth of that common sense which has characterized your very distinguished business career; you have taken us to-night over a range as wide as separates the study of the consumption of ice cream from the economic effects of communism on trade development in the several parts of the world. You say that your approach to business is exemplified by trying to sell more soap and more margarine; you have not mentioned that your business seeks to make more profits; in that abstention you have bowed to the temper of the time.

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So many of the things in your paper were interesting, but none more so than your statement that we must have judgment as well as knowledge: that is a very profound observation, because many people have so much knowledge and so little judgment. You have told us, and I do not know how you dared to do it, that you feel "something in your bones." I know what you mean: you and I have been trained in the same sort of school, but most of these academic gentlemen do not know anything about their bones—they rely upon their brains rather than on their bones.

I was interested in your suggestion that the validity of one's intuitions should be checked occasionally by a spot of knowledge. Those of us who have had the responsibility of conducting a business enterprise on a large scale know how very often we might be misled by the people who, with great fervour, come and tell us what they "feel in their bones," but have not troubled their brains to look up the facts of the situation.

Your Presidency of this Society will give great encouragement to statisticians. More and more in our lifetime—your lifetime fortunately is not quite as long as mine—we have seen the considerable growth of statistical departments in business houses. In my early days we did not have them: business men relied much more upon their bones than they do now, but I have also seen, as you have I am sure, the overgrowth of statistical departments till they almost submerged the people at the head of the business enterprise under a mass of relevant and irrelevant statistical data.

I would not dare to indulge in any criticism of what you said, but I was just a little worried about one phrase that you used two or three times—"tailored statistics." I wondered who was going to do the cutting, and to what particular pattern the cloth would be cut. Cutting is a matter of personal judgment—and maybe of prejudice. There is certainly a danger when politicians use tailored statistics—but you would not know anything about politicians and their occupational peculiarities!

Sir, we are grateful to you for having accepted this office, which we have given to you in the hope that you regard it as an honourable office; and we are thankful to you for the paper which you have read to us.

Dr. E. C. Snow: I am very glad to have the opportunity of speaking to Sir Geoffrey Heyworth's address. It has been a tradition in the Society for many years that the discussion on the President's speech should be confined to a proposer and seconder of the vote of thanks. A few years ago one rash President broke that long-established custom and asked for discussion and criticism, which he got in full measure. Having been the President who broke the tradition, I can have no ground for objecting to another variation of it, and gladly accept this invitation to speak to-night.

Our President's address is brief, as Presidential addresses go, but it is full of concise sentences which embody much wisdom and advice for statisticians. On reading the paper I found a dozen or so sentences which were gems in the art of compression, summarizing much experience in a little space. "Business statistics have to be simple" is an aphorism to be taken to heart by the statistician who may be confronted with a mass of material which he has to condense into something simple for his chief. The statistician knows that he has often a very difficult task to get the degree of simplicity which is needed to give a concise idea of what the mass really boils down to. An instance early in the 1914–18 war, when the question of the supply of wool for France became a matter of acute concern, has long stuck in my memory. A conference with our ally had to be held at the very highest level, and the Secretary of State for War, Lord Derby, took the chair. Government departments were rather deficient in statisticians at that time, and a young man who was a temporary Civil Servant was pressed into the job of trying to help Lord Derby at the meeting. The meeting had proceeded for some time when Lord Derby turned to him and said, "What is the price of wool?" The young statistician started to explain that there were a large number of types and qualities of wool, the prices ranging from 7*d.* to 50*d.* Lord Derby cut him short and said, "I have asked you a simple question and I want a simple answer, 'What is the price of wool?'." This assumption that there must be a simple answer to a simple question is widespread, and has probably been the cause of embarrassment to many other statisticians. Nevertheless, it is often essential that some simple answer must be provided.

As Sir Geoffrey has said, too many figures complicate judgment even more than too few, and the statistician's judgment has to be governed by instinct and by knowledge just as much as that of the administrator whom he is advising. The statistician in business, as the President points out, must not be content with producing masses of tables and walls of charts summarizing all the material he has had to handle; he must have a clear idea of what they are intended to convey, and be able to distil the essence from them. The statistician in business has more encouragement to develop his capacity to this end than has one in a Government department. The statistician

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in a commercial organization knows that he has some chance of becoming an administrator in due course. I know how wide is the gulf in a Government department between the statistician and the administrator, and official administration, I think, suffers from this well-established divorce. In the business world it is possible to instance a number of cases where the chief of a big concern has started in it as a statistician, but as he happened to have the instinct and judgment to which the President has referred, in addition to sound knowledge of all the facts of the business, which can be best attained by constant contact with the statistics relating to the business, his promotion was, in the absence of definite obstacles in the way, a natural move. I know of no reason why the man or the woman whose flair is for figures should be less well endowed with the instinct for judgment than the man or woman whose flair is for salesmanship or minute writing, and they have the advantage of the years spent with the figures to give them the sound foundation of wide knowledge which is essential.

Sir Geoffrey's address is mainly concerned with the statistics needed on the commercial side of a business. He does, however, refer to productivity figures, and these relate mainly to the manufacturing or industrial side. The use of statistics for the comparison of the productivity of different firms in an industry, or of similar firms in different countries, is relatively recent, and here it seems to me that the chief requisite of the statistician is the ability to spot fallacies in the use of the figures. These fallacies, and many others met with in the realm of business, frequently arise from the fact that the basis of comparison is faulty or that the data under observation are not homogeneous. Recently a leader of the French footwear industry told me that he was puzzled by the difference in footwear consumption in this country and in France, because the crude figures indicate that more boots and shoes per head of the population are consumed in this country than in France, and he could not see the reason for it. But there is a fallacy in making the comparison, because the make-up of the French population is different from the make-up of the British population. We are more urban and less rural than the French population. It may well be that the consumption of footwear in the urban areas in the two countries is much the same, and similarly for the rural areas, while in each country the urban consumption is appreciably higher than the rural. Because there is a bigger urban population in this country than in France, the total figure of consumption per head is naturally higher here. This type of fallacy abounds in the comparison of generalized productivity figures, and I gave some instances in a paper presented to the Society some years ago* which provided illustrations of the need to keep a good look-out for possible statistical fallacies in handling productivity data. The President's warning that the test of the proper use of statistics is the skill with which the user combines his own knowledge with the figures to produce a balanced judgment is timely. If he is not familiar with the subject-matter, the student of productivity reports should always beware of possible pitfalls in interpreting the statistics in them. Sir Geoffrey well says, "The more facts one has, the better judgment one must make; but one must not forget the corollary—the more facts one has the easier is it to put them together wrongly. The final test is how deeply one can guess." The man with knowledge of the subject-matter should guess better than the man without it.

Sir Geoffrey has struck something new in Presidential addresses. In comparison with others it is short, but it is likely to be more studied than the bulk of the others, particularly by younger statisticians. I am not now familiar with the curriculum required for examinations in statistics in the Universities, but if the writing of an essay on some aspect of statistics is included, I can foresee that examiners will find various sentences in the address very suitable to provide subjects for such essays. The Society is fortunate indeed to have this particular address from one who is so well qualified in every respect for writing it.

The vote of thanks was put to the meeting and carried unanimously.

The PRESIDENT: I thank you most heartily and sincerely for the nice things you have said about me and my Address. When I was asked to become your President and was told the rules, it did appeal to me that I should be able to make an address and not be criticized. Past Presidents are, of course, very privileged people, as they should be, but there is one observation which I might touch on. Lord Woolton pointed out that I was in the fashion by not mentioning the word "profit," but you will notice that throughout the address I was concerned about prices and costs, which, I believe, are the same thing. I still know the difference between a red figure and a black one.

I thought there would be some comment on the reference to intuition and a feeling "in the bones," but I shall not take anything back on that point. I think that you must have these feelings,

* *J.R. Stat. Soc.*, cvii, 1944, "The International Comparison of Productivity."

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otherwise why would anybody be an expert in anything? It cannot all be just looking at pieces of paper; it is what you see behind that adds up to something worth while.

I must apologize for using the word "tailored"; I forgot the Past President had a closer knowledge of the tailoring trade than I have, and he gave it a sinister meaning which had not occurred to me. I think I was indirectly paying a compliment to statisticians, because the man I am talking about is a man of integrity and character, and I do not think he would distort figures, if that is what "tailoring" means.

I feel much better than when I stood up to address you, and I am looking forward greatly to the opportunities I hope to have in the forthcoming year to see and be with people in the statistical professions. I know that I shall profit by it, and you will therefore have collectively done me a service in taking my education just that much further. I feel extremely grateful for this opportunity of being your President.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Alec Harold Adams.
Fouad Angurli.
Cyril Joseph Anson.
P. S. Arumugam.
Ernest Hopwood Badcock.
Keith Lambert Barker.
Gertrude Isabella Bateman.
Jerzy Berent.
Archie Blake.
Enrique Loizelier Blanco.
Edward Constable Brooksbank.
James Brown.
Henry James Cox.
Albert Douglas Crombie.
John Russell Dashwood.
Peter Greenslade Downing.
Thomas Ewan Faulkner.
George Gallia.
Walter Howitt Gamble.
William Gatherer.
Kenneth Frank Glover.
Daniel Gold.
Kenneth Charles Thomas Gordon.
Jane Gray.
Isidor Grobstein.
Gerald Vernon Haydon.
Vasant Shankar Huzurbazar.
Thomas Cledlyn Jones.
Dip Narayan Lal.
Tay Boh Lim.
Norma Ruth McArthur.
John Donald McCullen.
Joseph Percy Mackenzie.
Arthur Eric Maddison.
Claud Victor Manley.
Hugh Wright Mellor.
John Patrick Molony.
Peter Stinson Neall.
Christian Emmanuel Noah.
Nicholas Papafilis.
Frank Douglas Parr.
James Watson Parsons.
Alfred Deans Peggs.
Leonard Pinshow.
Niuma Benjamin Rajchenbaum.
Frederick William Rew.
William David Richards.
Reginald Arthur Robson.
Marion Howard Russell.
Fernando Habib Sadek.
Shiva Shankara.
John Gordon Skellam.
P. V. Sivarama-Murthy.
Alan Stuart.
James Oladipo Williams.

Corporate Representatives

Edward Cecil Baker, *representing* The Post Office Library.
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The U.K. Mercantile Marine and its Contribution to the Balance of Payments

By M. G. Kendall

[Read before the Royal Statistical Society, Thursday, December 8th, 1949, Dr. David Heron, Ex-President, in the Chair.]

Introduction

1. Twelve years ago my predecessor in the office of statistician to the Chamber of Shipping, Dr. Leon Isserlis, read to this Society a classical paper on "Tramp Shipping, Cargoes and Freights," in the course of which he gave an account of two inquiries into the contribution of U.K. shipping to our invisible exports which had been undertaken by the industry, at the request of the President of the Board of Trade, for the years 1931 and 1936. In this paper my main object is to continue his work by giving the results of a third inquiry, also undertaken by the industry at the Government's request, covering the year 1947. But before dealing with the balance of payments I present some new figures relating to the U.K. merchant fleet, and discuss the possibility of resuming a tramp-freight index for the post-war years.

The U.K. Merchant Fleet at June, 1949

2. The statistics of numbers and tonnage of U.K. ships published by Lloyd's Register of British Shipping cover all non-naval vessels on the U.K. register, whether trading or not, and include, for example, a substantial number of fishing vessels and tugs. Moreover, they do not distinguish merchant vessels by type (passenger liner, cargo liner and tramp), although they separate dry-cargo ships from tankers. From the shipping industry's point of view these are considerable drawbacks, and in 1948 it was felt that more detailed records were necessary. Accordingly, with the help of the shipowners themselves, we constructed at the Chamber of Shipping a card index which was confined to trading merchant vessels. It was intended to be as near completeness as makes no difference for statistical purposes, and it embodied a certain amount of information not always given in published form, such as the deadweight tonnage and the number of passengers for whom accommodation was available. In addition to privately-owned tonnage it included Government tonnage engaged in ordinary commercial employment, but it excluded Admiralty tankers, ships registered in the U.K. by non-U.K. owners, and ships registered outside the U.K. by U.K. owners. Our object was to compile records of ships owned by U.K. companies, registered in the U.K. and operating in the commercial carriage of passengers and cargo.

3. The cards of the index were classified (by their colour) into three main types, liner, tramp, and tanker; and each type was divided into two groups, "coasting and home-trade" and "foreign-going" vessels.* In carrying out these classifications we used information from the owners themselves about the nature of the vessels' employment. The only difficulties I need mention arose on vessels which are sometimes tramp and sometimes liner, and on vessels which trade sometimes within coasting and home-trade limits and sometimes outside them. In these borderline cases we allotted the vessels to one category or the other from what the owners were able to tell us about their customary employment, coupled with reference to the actual trading experience of the year 1947 when necessary.

4. The statistical information derivable from this index has already proved its value in providing information needed by the industry in its work on shipping policy. In Tables 1–13 are presented analyses of the fleet as it existed on June 30th, 1949, classified by size, type of propulsion and age, Table 13 being a summary of the totals.

* For a more detailed account of the various kinds of tonnage and the various categories of classification used for U.K. shipping reference may be made to my article (1948*a*) on "U.K. Merchant Shipping Statistics."

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TABLE 1.—*Foreign-going Liners, U.K. Registered and Owned, at* 30.vi.1949, *by Size and Propulsion*

Gross tons	*Coal-fired steamers (number of ships)*	*Oil-fired steamers (number of ships)*	*Diesels (number of ships)*	*Total (number of ships)*
Under 1,000	12	4	8	24
1,000–	12	3	8	23
1,500–	22	14	10	46
2,000–	12	10	4	26
2,500–	13	8	6	27
3,000–	12	9	9	30
3,500–	6	8	13	27
4,000–	—	5	8	13
4,500–	9	14	18	41
5,000–	35	18	24	77
5,500–	14	17	19	50
6,000–	15	15	13	43
6,500–	23	15	30	68
7,000–	44	130	36	210
7,500–	6	32	13	51
8,000–	11	27	25	63
8,500–	4	20	15	39
9,000–	1	10	7	18
9,500–	1	26	23	50
10,000–	5	37	58	100
15,000–	—	19	6	25
20,000–	—	17	3	20
25,000–	—	5	6	11
30,000 and over	—	5	—	5
Total: Numbers	257	468	362	1,087
Gross tons (000)	1,309	4,091	2,749	8,149

TABLE 2.—*U.K. Foreign-going Liners, U.K. Registered and Owned, at* 30.vi.1949, *by Age and Propulsion*

Years of build	*Coal-fired steamers*		*Oil-fired steamers*		*Diesels*		*Total*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
1892	1	1	—	—	—	—	1	1
1905–09	—	—	1	5	—	—	1	5
1910–14	17	112	9	146	—	—	26	258
1915–19	29	172	21	169	2	13	52	354
1920–24	49	208	60	564	18	111	127	883
1925–29	39	154	26	304	46	365	111	823
1930–34	14	46	18	207	30	274	62	527
1935–39	23	121	40	444	66	535	129	1,100
1940–44	66	390	137	1,086	71	552	274	2,028
1945–49	19	105	156	1,166	129	899	304	2,170
Totals	257	1,309	468	4,091	362	2,749	1,087	8,149

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TABLE 3.—*Foreign-going Tramps, U.K. Registered and Owned,* 30.vi.1949, *by Size and Propulsion*

Gross tons	*Coal-fired steamers (number of ships)*	*Oil-fired steamers (number of ships)*	*Diesels (number of ships)*	*Total (number of ships)*
500–	3	—	1	4
1,000–	2	2	1	5
1,500–	37	3	—	40
2,000–	11	3	2	16
2,500–	35	7	—	42
3,000–	11	3	1	15
3,500–	22	5	—	27
4,000–	20	4	3	27
4,500–	33	12	17	62
5,000–	35	20	38	93
5,500–	13	10	3	26
6,000–	13	1	1	15
6,500–	15	7	4	26
7,000–	66	71	39	176
7,500–	3	9	4	16
8,000 and over	2	2	1	5
Totals: Number	321	159	115	595
Gross tons (000)	1,509	951	678	3,138

TABLE 4.—*Foreign-going Tramps, U.K. Registered and Owned,* 30.vi.49, *by Age and Propulsion*

Years of build	*Coal-fired steamers*		*Oil-fired steamers*		*Diesels*		*Total*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
1905–09	2	2	1	1	—	—	3	3
1910–14	4	17	1	1	—	—	5	18
1915–19	10	39	5	29	—	—	15	68
1920–24	29	110	4	19	3	15	36	144
1925–29	59	279	8	43	12	65	79	387
1930–34	24	105	4	21	2	8	30	134
1935–39	22	100	11	54	21	105	54	259
1940–44	150	750	100	643	53	344	303	1,737
1945–49	21	107	25	140	24	141	70	388
Totals	321	1,509	159	951	115	678	595	3,138

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TABLE 5.—*Foreign-going Tankers, U.K. Registered and Owned,* 30.vi.49, *by Size and Propulsion*

Gross tons	*Oil-fired steamers (number of ships)*	*Diesels (number of ships)*	*Total (number of ships)*
100–	—	9	9
500–	9	10	19
1,000–	4	—	4
1,500–	4	2	6
2,000–	12	—	12
2,500–	1	2	3
3,000–	2	—	2
3,500–	3	11	14
4,000–	6	1	7
4,500–	2	—	2
5,000–	2	1	3
5,500–	12	4	16
6,000–	7	27	34
6,500–	8	12	20
7,000–	7	19	26
7,500–	—	3	3
8,000–	9	100	109
8,500–	2	36	38
9,000–	—	4	4
9,500–	12	8	20
10,000–	—	4	4
10,500–	48	—	48
11,000–	—	4	4
11,500–	—	—	—
12,000–	2	3	5
12,500–	—	1	1
13,000 and over	2	—	2
Totals:			
Number	154	261	415
Gross tons (000)	1,103	1,892	2,995

Note.—The table does not include Admiralty tankers, amounting to about 335,000 gross tons.

TABLE 6.—*Foreign-going Tankers, U.K. Registered and Owned,* 30.vi.1949, *by Age and Propulsion*

Years of build	*Oil-fired steamers*		*Diesels*		*Total*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
1900–04	1	2	—	—	1	2
1905–09	—	—	—	—	—	—
1910–14	1	5	4	10	5	15
1915–19	15	59	—	—	15	59
1920–24	24	159	3	16	27	175
1925–29	21	83	29	197	50	280
1930–34	3	13	20	151	23	164
1935–39	5	25	59	455	64	480
1940–44	54	513	60	435	114	948
1945–49	30	244	86	628	116	872
Totals	154	1,103	261	1,892	415	2,995

Note.—The table does not include Admiralty tankers.

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TABLE 7.—*Coasting and Home-Trade Liners, U.K. Registered and Owned, 30.vi.1949, by Size and Propulsion*

Gross tons	*Coal-fired steamers (number of ships)*	*Oil-fired steamers (number of ships)*	*Diesels (number of ships)*	*Total (number of ships)*
100–	7	—	5	12
200–	8	1	8	17
300–	11	2	15	28
400–	11	2	19	32
500–	9	4	22	35
600–	7	1	10	18
700–	17	7	4	28
800–	10	5	8	23
900–	8	1	12	21
1,000–	48	2	18	68
1,500–	18	16	4	38
2,000–	4	11	2	17
2,500–	1	8	—	9
3,000–	—	7	2	9
3,500–	4	2	1	7
4,000–	—	6	1	7
4,500–	—	1	2	3
5,000–	—	—	—	—
5,500 and over	—	1	—	1
Totals: Number	163	77	133	373
Gross tons (000)	163	160	115	438

TABLE 8.—*Coasting and Home Trade Liners, U.K. Registered and Owned, 30.vi.1949, by Age and Propulsion*

Years of build	*Coal-fired steamers*		*Oil-fired steamers*		*Diesels*		*Total*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
1875–79	2	*	—	—	—	—	2	—
1880–84	2	1	—	—	—	—	2	1
1885–89	1	*	—	—	—	—	1	*
1890–94	3	1	—	—	—	—	3	1
1895–99	4	2	2	1	—	—	6	3
1900–04	8	6	1	2	—	—	9	8
1905–09	12	8	4	5	1	*	17	13
1910–14	13	15	6	9	—	—	19	24
1915–19	9	9	4	7	1	*	14	16
1920–24	35	37	5	9	—	—	40	46
1925–29	31	35	11	20	6	5	48	60
1930–34	22	23	13	31	9	5	44	59
1935–39	14	16	5	8	52	42	71	66
1940–44	5	6	2	6	21	13	28	25
1945–49	2	4	24	62	43	50	69	116
Totals	163	163	77	160	133	115	373	438

* Tonnage less than 500.

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TABLE 9.—*Coasting and Home-Trade Tramps, U.K. Registered and Owned, 30.vi.1949, by Size and Propulsion*

Gross tons	*Coal-fired steamers (number of ships)*	*Oil-fired steamers (number of ships)*	*Diesels (number of ships)*	*Total (number of ships)*
100–	22	1	39	62
200–	41	3	32	76
300–	52	1	42	95
400–	54	5	37	96
500–	38	1	32	71
600–	31	1	7	39
700–	19	—	4	23
800–	34	—	7	41
900–	25	5	7	37
1,000–	64	1	4	69
1,500–	54	1	5	60
2,000–	21	—	—	21
2,500–	35	—	1	36
3,000 and over	1	—	—	1
Totals: Number	491	19	217	727
Gross tons (000)	479	12	97	588

TABLE 10.—*Coasting and Home-Trade Tramps, U.K. Registered and Owned, 30.vi.1949, by Age and Propulsion*

Years of build	*Coal-fired steamers*		*Oil-fired steamers*		*Diesels*		*Total*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
1885–89	—	—	—	—	1	*	1	*
1890–94	11	4	—	—	—	—	11	4
1895–99	5	2	—	—	3	*	8	2
1900–04	18	8	—	—	8	1	26	9
1905–09	28	11	—	—	2	*	30	11
1910–14	44	26	—	—	6	1	50	27
1915–19	63	47	1	*	6	1	70	48
1920–24	113	85	1	*	7	1	121	86
1925–29	49	52	1	1	5	1	55	54
1930–34	36	37	—	—	22	7	58	44
1935–39	39	46	2	2	67	30	108	78
1940–44	41	85	2	1	53	25	96	111
1945–49	44	76	12	8	37	30	93	114
Totals	491	479	19	12	217	97	727	588

* Tonnage less than 500.

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TABLE 11.—*Coasting and Home-Trade Tankers, U.K. Registered and Owned, 30.vi.1949, by Size and Propulsion*

Gross tons	*Coal-fired steamers (number of ships)*	*Oil-fired steamers (number of ships)*	*Diesels (number of ships)*	*Total (number) of ships*
100–	—	—	7	7
200–	—	3	11	14
300–	1	—	11	12
400–	—	4	5	9
500–	2	—	—	2
600–	1	1	3	5
700–	—	9	1	10
800–	—	7	3	10
900–	—	2	3	5
1,000–	—	6	1	7
1,500–	—	1	1	2
Totals: Number	4	33	46	83
Gross tons (000)	2	26	21	49

TABLE 12.—*Coasting and Home-Trade Tankers, U.K. Registered and Owned, 30.vi.1949, by Age and Propulsion*

Years of build	*Coal-fired steamers*		*Oil-fired steamers*		*Diesels*		*Totals*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
1895–99	1	*	—	—	1	*	2	*
1910–14	—	—	1	1	—	—	1	1
1915–19	—	—	3	3	2	*	5	3
1920–24	1	1	9	5	7	2	17	8
1925–29	2	1	6	5	6	2	14	8
1930–34	—	—	2	2	6	2	8	4
1935–39	—	—	—	—	11	6	11	6
1940–44	—	—	9	7	7	4	16	11
1945–49	—	—	3	3	6	5	9	8
Total	4	2	33	26	46	21	83	49

* Tonnage less than 500.

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TABLE 13.—*Summary of Tables* 1–12, *Showing Vessels Owned and Registered in the U.K.*, 30.vi.1949, *by Type and Propulsion*

	Coal-fired steamers		*Oil-fired steamers*		*Diesels*		*Total*	
	Number	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*	*Number*	*Gr. tons (000)*
Foreign-going:								
Liners	257	1,309	468	4,091	362	2,749	1,087	8,149
Tramps	321	1,509	159	951	115	678	595	3,138
Tankers	—	—	154	1,103	261	1,892	415	2,995
Coasting and H.T.:								
Liners	163	163	77	160	133	115	373	438
Tramps	491	479	19	12	217	97	727	588
Tankers	4	2	33	26	46	21	83	49
Total	1,236	3,462	910	6,343	1,134	5,552	3,280	15,357

5. A few features of the tables deserve comment:

(a) *Size.*—The remarkable range of size in the U.K. fleet emerges clearly. For foreign-going liners there is a "favourite" or modal size at about 7,000 gross tons and another at 10,000 gross tons, but every size is well represented. For foreign-going tramps there are two modal sizes, one at about 5,000 gross tons—a popular size pre-war—and one at about 7,000 gross tons, a wartime product which may or may not retain its popularity; and for tankers the modal sizes are greater, there being one at 8,000 gross tons, and a second at 10,500 gross tons. The existence of these modes illustrates the tendency towards standardization, which is more marked for tankers than for tramps.

In the coasting and home trade groups the distribution over size-categories is more regular—a reflection of the more intimate nature of coastal traffic, and the necessity for it to adapt itself to port, harbour, or even river capacities.

(b) *Propulsion.*—Of the 2,097 foreign-going vessels, representing about 14·3 million gross tons, 20 per cent. by tonnage burn coal, 43 per cent. are oil-fired steamers, and 37 per cent. have diesel engines. Thus only a fifth of our foreign-going fleet burns coal. The proportion in 1914 was over 85 per cent., and as late as 1935 was about 50 per cent. We seem to be approaching the time when oil ousts coal just as coal ousted wind as the major propellant of ships. The reason is not merely that oil is cheaper than coal. The oil burner effects economies in space and in engine room manning.

In the coasting and home-trade groups the proportion of coal burners is higher. Of 1,183 vessels, representing about 1,075,000 gross tons, 60 per cent. burn coal, 18 per cent. are oil-fired steamers, and 22 per cent. are diesels.

(c) *Age.*—Perhaps the most interesting feature of the tables lies in the age-constitution of the fleet. In Table 14 I summarize the position for all classes of ship together, but give the years of build in units of one, not of five as in Tables 1–12.

6. It is not part of my present purpose to discuss the implications of Table 14 in detail, but one feature is worthy of special comment, namely, the distorted age distribution due to wartime and post-war buildings. As the vessels wear out the replacement of the fleet in an orderly way so as to distribute the load as evenly as possible over a period of years is evidently going to be a problem of the first magnitude. For example, the U.K. buildings for domestic account since the war have been about 700,000 gross tons per annum. If this continued for another five or six years and the older ships left the register to make room for the new tonnage we should arrive at 1956 with a decade before us in which building requirements might fall to an annual level well below 500,000 gross tons; and thereafter they would rise again as the war-built tonnage became obsolete. I hope that nobody will attach too much weight to the assumptions on which this statement is predicated, which may well be falsified by the history of the industry in the next ten years; but they will give some idea of possible fluctuations in demand on the shipbuilding yards in the future,

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TABLE 14.—*Age Distribution of the U.K. Fleet Covered by Tables* 1–12
(*Vessels of* 100 *Gross Tons and Over*)

Year of build	*Gross tonnage* (000)	*Cumulated percentage* (*proportion built in the given year or earlier*)
1929 or earlier	3,908	24·7
1930	393	27·2
1931	229	28·6
1932	117	29·4
1933	104	30·0
1934	89	30·6
1935	292	32·4
1936	493	35·5
1937	415	38·2
1938	373	40·5
1939	416	43·2
1940	463	46·1
1941	496	49·2
1942	998	55·5
1943	1,438	64·6
1944	1,465	73·9
1945	1,014	80·3
1946	734	84·1
1947	739	89·6
1948	713	94·1
1949 (estimated)	934	100·0
	15,823	

and of the use of tables of the type of Table 14 in enabling forecasts to be made with some actuarial justification.

7. The data of Tables 1–14 are, of course, of a new type, and no information on a strictly comparable basis is available for pre-war years. Now that the U.K. mercantile marine has been rebuilt interest is naturally focused on comparisons between 1949 and 1939, and in order to make them I must draw on other sources. Before doing so, I might mention that the total tonnage of foreign-going vessels of 3,000 gross tons and over, given by Tables 1, 3 and 5, is about 13·7 mns., which is short by about 1·2 mn. gross tons of the official figures given by the Registrar of Shipping in what are usually known as the G.R. 128 returns. The whole of this difference has not yet been accounted for; but a good deal of it is attributable to tonnage owned in the Dominions but registered in the U.K. (perhaps about 300,000 gross tons), Admiralty tankers (about another 300,000 gross tons), whaling factories and catchers (about 100,000 gross tons), and probably some vessels used as storage hulks and for similar purposes which are, of course, not trading (amount unknown). This difference should not seriously affect comparisons of average size or average age, and in making the comparisons below I have worked on the available official pre-war information for 1939 and on the card-index figures for 1949; but in comparing total tonnages I have worked on the official figures for both years.

8. Briefly, then, the situation is this. By now the U.K. fleet has practically returned to its 1939 strength—a truly remarkable achievement considering the magnitude of its losses in the war and the financial problems of reconstruction.* The proportions of different type in the foreign-going trades, however, have changed appreciably. In 1949 about 58 per cent. of our fleet was liner tonnage, as compared with 59 per cent in 1939; but tramp tonnage was about 21 per cent.

* An analysis of these losses and of the insurance recoveries on them is given in my article in *Economica* (1948*b*).

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in 1949 as compared with 23 per cent. in 1939, and tanker tonnage was 21 per cent. in 1949 as compared with 18 per cent in 1939. Since the rise in tanker tonnage is chiefly due to the increasing use of oil this change in the make-up of the U.K. fleet is likely to be permanent. I am sorry that difficulties of disentangling coasting vessels from other vessels of comparable size in pre-war figures renders it impossible to make similar comparisons for the coasting and home-trade fleet.

9. Again, on the basis of vessels of 3,000 gross tons and over, there is a definite increase in average size for all three types of vessel in the post-war period, as shown by the following figures:

TABLE 15(*a*).—*Average Size of Vessels* (3,000 *Gross Tons and Over*) *in* 1939 *and* 1949

	At Sept. 3rd, 1939, *gross tons*	*At June 30th*, 1949, *gross tons*
Liners	8,000	8,400
Tramps	4,800	6,000
Tankers	7,500	8,100
All types	6,800	7,700

The large increase in the average size of tramps is due to the numbers of war-built "Liberty" type ships in the 1949 fleet. It does not follow that this increase is permanent, because when new tramps are built (there are very few under construction now) they may be smaller than the 7,000-ton Liberties. On the other hand, tankers may show a further increase in average size in future years.

10. A similar comparison of ages for the vessels of 1,600 gross tons and over (the average being weighted according to the tonnage involved) is as follows:

TABLE 15(*b*).—*Average Age of Foreign-going Vessels in* 1939 *and* 1949

	At Sept. 3rd, 1939 (*years*)	*At June 30th*, 1949 (*years*)
Liners	14·6	12·6
Tramps	12·7	10·5
Tankers	10·8	10·0
All types	13·4	11·6

All classes have been partly rejuvenated, but I have pointed out above the distorted age-distribution which lies behind these average figures.

11. It would have been pleasant to have been able to give a comparable statement for speeds, but unfortunately the information is not sufficiently complete. It has, however, been stated by the President of the Chamber of Shipping that cargo liners are 6 per cent. faster than before the war, and one would expect to find some increase in the tramp and tanker fleets, though probably not so much.

Index of Tramp Shipping Freights

12. In his 1938 paper Dr. Isserlis dealt very fully with the subject of tramp shipping freights, gave a chain index for the years 1869–1936 inclusive, and described an index prepared in the Chamber of Shipping from 1920 to 1937. These indices were necessarily rather rough measures of freight movements, because there were, at the time, no data to provide a satisfactory system of weighting. This gap in our knowledge was filled by information obtained under the administration of the British Shipping (Assistance) Act, 1935, which provided complete and exact information about tramp voyages, cargoes carried and freights earned in the foreign trade by tramp vessels registered in the United Kingdom.

13. With the aid of these data Dr. Isserlis obtained a system of weights based on the gross freights (not tons weight) of cargoes carried by British tramps in 1935 (see Table X of his paper).

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The commodities were classified in seven groups, Coal, Grain, Timber, Ore, Fertilizers, Sugar, and Iron-steel-scrap, a number of main routes being itemized for each group. Freight rates were obtained from the *Daily Freight Register*, and link-relatives, based on 1935 = 100, calculated for each route and hence for each group. Arithmetic averages were used in all cases, and the index calculated for each month. The work continued at the Chamber of Shipping until the outbreak of war in 1939 brought it to an end.

14. British shipping was released from requisition in March, 1946, except for tankers, which were released in the previous January. It did not, however, become free in the sense of pre-war commerce. For some time there was direction of employment and the rates of freight were controlled. Although the control was progressively released, the principal *inward* voyages to the U.K. for grain, timber, fertilizers, and sugar remained under control throughout most of 1948. Nor was the system of freight-control uniform. Deep-sea tramp freights, when controlled at all, were fixed at definite levels; but at one stage outward freights and cross freights were free, while inward freights were controlled, and throughout the control period short sea freights were subject only to maxima.

15. It has thus been impossible to resume Isserlis's index exactly in the form in which he originally designed it. I had to examine the desirability or necessity of amendments in the following respects:

(a) *Routes*.—The 1948 pattern of bulk-cargo movements by sea was different from that of pre-war days. But it was not so very different, if only because the main producing and consuming areas remained the same. The relative volumes of traffic altered, but the routes were similar. Nevertheless, I had to make some alterations as follows (the references corresponding to those in Isserlis's paper):

Group 1 (*a*).—Coal: No. 12 Cardiff or Newport/Oporto was taken to include Cardiff or Newport/Lisbon.

Group 1 (*b*).—Coal: Nos. 1–8, 11. Bristol Channel rates were used irrespective of which loading port in the Bristol Channel was used.

No. 12. Antwerp/Genoa, Savona, etc., was replaced by Antwerp, Rotterdam/West Italy.

Group 2.—Grain: No. 1. Albany/U.K. Continent was replaced by U.S. Northern Range/U.K.

No. 2. Montreal/U.K. Continent was replaced by St. Lawrence/U.K.

Nos. 3–6. During the period of control Bahia Blanca, Buenos Aires, Rosario, Santa Fe/U.K., Continent, were replaced by River Plate/U.K.

No. 7. North Pacific/U.K., Continent (f.i.o.) was replaced by North Pacific/U.K (f.i.o.).

Nos. 11 and 12. Bagged cargoes were replaced by bulk cargoes. As Australian rates were zoned during the control period according to the area from which the vessel proceeded to the loading port in Australia, the Middle Zone (Red Sea, etc.) was taken as the standard starting place.

No. 15. Roumania/Antwerp, Rotterdam, was replaced by Black Sea/Antwerp, Rotterdam

Group 4.—Ore: North African ports were grouped into Algerian, Tunisian and Moroccan ports and "U.K." substituted for a particular port in the U.K.

Group 7.—Iron-steel-scrap: This group has not been represented since the beginning of 1948, and had to be omitted.

(b) *Weights*.—Information was available about the estimated tonnage (weight) of bulk imports into the U.K. for 1948 (though not, unfortunately, for the cross-trades). This, coupled with estimated coal exports, enabled me to calculate 1948 weights for comparison with Dr. Isserlis's original weights. In the following Table 16 I give for the main groups (*a*) Isserlis's 1935 weights and (*b*) my 1948 weights. The latter are not very exact, but, as is well known, great accuracy in weighting systems is scarcely ever required. It must be remembered that of the 1935 weights about 47 per cent. by value was attributable to cross voyages; the 1948 weights relate entirely to voyages to and from the U.K.

The most striking difference between the two sets of weights is the much higher proportion attributable to grain in the 1935 weights. This is partly due to the fact that grain has a relatively higher freight, the 1935 weights being based on freights and the 1948 weights on tons, and partly

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TABLE 16.—*Weights Used in the Freight Index Number.*

	1935 *Weights (based on gross freights)* (%)	1948 *Weights (based on tons)* (%)
1. (*a*) Coal	8·62	18·75
1. (*b*) Coal	18·96	
2. Grain	50·57	28·11
3. Timber	3·17	12·50
4. Ore	6·87	26·88
5. Fertilizers	4·82	5·00
6. Sugar	4·61	4·38
7. Iron and steel	2·38	4·38
Totals	100·00	100·00

to the relatively greater weight of imports of ore in 1948 as compared with 1935. (In the discussion of Dr. Isserlis's paper, Mr. Leak of the Board of Trade criticized the index on the grounds that the weighting for grain was too high.) Before embarking on a long discussion, however, concerning the relative merits of the two systems, it is as well to see how far the differences affect the final index. (See paragraph 16.)

(c) *Prices.*—A great many of the freights concerned were controlled in 1948 and were therefore known without reference to the Daily Freight Register, although it was still necessary to consult the Register to see if there had been any fixtures. Where different rates were prescribed for different sizes of ship the rate for the "modal" ship was used, this being the size used for costing the controlled rate concerned in the first instance. Free rates *for British ships* (and for foreign ships when expressed in sterling) were taken from the Register as before.

(d) *Base year.*—This was perhaps the most difficult point of all to decide. I began with the idea of transferring the base year from 1935 to 1938, this being the last pre-war year, which is used fairly generally for current economic index numbers. But a comparison of 1948 with 1938 really conveys very little because of some important alterations in the nature of sea transport. There were fewer ships engaged in 1948 than in 1938; those that were engaged were hampered by delays in port; hauls were longer on the whole; and the fall in our coal exports involved more outward passages in ballast. On the other hand, vessels were on the average faster and larger.

Now an index of freight rates, however cautiously it is promulgated, is always in danger of being interpreted as an index of earnings; and, indeed, in less responsible or informed quarters may even be used as an index of profits. For the reason I have stated the relation of the index to 1938 may give rise to serious misunderstanding. The fact that on the 1938 basis the index of freights was 330 for 1948 does not by any means imply that earnings or profits were 3⅓ times as great as in 1938—and even if it did the change in the value of money would render the figure illusory.

I therefore decided to work on the basis of 1948 = 100. The link-relatives are based on 1938, the last complete pre-war year of open market freights, and the resulting index converted to the 1948 basis by dividing by 330. The 1948 basis may be only temporary if in future years the permanent level turns out to be substantially lower than in 1948. Isserlis encountered this trouble after World War I. When he began his preliminary index he took 1920 = 100. Before two years were up the index was running below 30 and remained there for the next fifteen years. A similar fall in freights after World War II has not occurred, and possibly may not occur. But some permanent fall below the 1948 level is probable, and until we can see a little more clearly into the future, the base 1948 = 100 must be considered as temporary. The layman is always apt to regard the basic figure of 100 as a norm to which he has the right to see his freights return.

16. To sum up, I have used Isserlis's routes with only minor alterations, which amount more to a change of description than a change of circumstance; in periods where different rates were being obtained by British and non-sterling vessels I have used the former, so that the new index is effectively one of *British* tramp freights; and the index is based on 1948 = 100. The only outstanding point concerns the weights, and here I experimented by calculating two indices, using

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the two weighting systems (*a*) and (*b*) of Table 16. The differences between the two results were very small. This does not mean necessarily that we are justified in continuing to use the 1935 weights, because when, as in the present case, the rates for different groups were constrained by control to keep on a parity, the final index is nearly independent of the weighting system; and as we move further from control the differences between the two types (*a*) and (*b*) may increase. However, I am far from being sure that the 1948 weights will be any nearer the ultimate stable pattern of our trade than the 1935 weights; and in any case they do not cover cross traffic. For the present, therefore, it seems reasonable to continue the 1935 weighting system. As time goes on it will have to be considered whether a new set of weights, including cross-voyages, is desirable, and whether a moving set of weights (such as is used for the agricultural price-index) would be more appropriate to a trade-distribution which is slowly changing in time.

The resulting index is shown in Table 17.

TABLE 17.—*Index Number of British Tramp Shipping Freights* (1948 = 100)

Year and month	*Index number*
1948:	
January	112
February	105
March	105
April	103
May	105
June	100
July	99
August	101
September	97
October	99
November	89
December	87
1949:	
January	87
February	101
March	95
April	95
May	100
June	87
July	73
August	71
September	72
October	70
November	67

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17. January, 1948, was exceptional because of some high coal freights in that month. Apart from this, the index remained fairly steady for the first nine months of the year: and this is to be expected when it is realized that during those months inward freights to the U.K. were to a large measure still controlled at fixed levels. On December 1st, 1948, the rates were freed concurrently with the relaxation of voyage direction and the winding up of transitional control, the administration of which, since October, 1947, had been delegated to a body of the industry known as the Shipping Advisory and Allocation Committee. It is a tribute to the judgment of the industry and of the Government that this transition was not accompanied by any marked discontinuity in freights. They sagged somewhat into January, 1949, but recovered in February, and remained fairly steady until May, 1949.

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18. At this point a new phase began. Freights fell appreciably in June, again in July and to a smaller extent in August. Shipowners naturally were beginning to ask themselves whether this was the beginning of a major slump when the pound was devalued and freights tended to rise again to offset the hard currency disbursements which many foreign-going vessels have to incur. The rise was, however, not a large one, and the main question whether freights will fall further remains open.

The Invisible Exports Inquiry for 1947

19. In June, 1948, the Minister of Transport asked the General Council of British Shipping* to carry out an inquiry into the contribution of U.K. shipping to our invisible exports. The Council readily undertook to do so, notwithstanding the burden which would be thrown on its constituents at a time when accounting staffs were already under heavy pressure of work. In August, 1948, forms of questionnaire and instructions were accordingly circulated to all constituents of the General Council concerned in trade outside coastal waters. Before issue these documents were discussed and agreed between officials of the General Council, the Treasury, the Board of Trade, the Bank of England, the Central Statistical Office and the Ministry of Transport. Points of procedure or interpretation which arose during the course of the inquiry (and there were a good many of them) were decided after consultation between the officials concerned. Confidential reports on the results of the inquiry were sent to the Minister of Transport in July, August and November, 1949.

20. The response to the inquiry was very good. Questionnaires were sent to 330 companies, some of them large groups responsible for numerous subsidiaries. Replies were received covering 99 per cent. of the effective tonnage trading in 1947, and the main reason for the failure to secure a return covering the remaining 1 per cent. was that a few companies had gone out of business, so that the information was no longer available. The industry may, I think, fairly be congratulated upon this achievement. The amount of work thrown upon some of the larger companies may be gauged from the fact that one (a tanker) estimated the time taken in completing the returns at 1,500 man-hours, and another (a large liner group) estimated the time as 7,500 man-hours. These are extreme cases, and there were doubtless instances at the other end of the scale where only a day or two's work were involved; but for a concern of any size the completion of a return was evidently a major operation.

21. It would take too long to detail all the issues requiring settlement in connection with the scope of the inquiry, but I ought briefly to refer to the more important ones:

(*a*) 1947 was chosen, not because it was a representative year, but because it was the only possible post-war year unless the inquiry was to be postponed.

(*b*) During that year, or part of it, a considerable amount of tonnage was engaged in troop-carrying, or was under reconversion from war-time employment. Owners were therefore asked for particulars of trading time so that the actual tonnage could be converted to effective trading tonnage, *e.g.* a 12,000 tonner trading for two months would be counted as 2,000 tons operating for a year.

(*c*) Some of the vessels engaged in carrying civilians or troops on Government account also carried some passengers or freight on commercial account. The items of receipt were separated, but the disbursements could not be distinguished and were all reckoned as disbursements on commercial account.

(*d*) During the year there was a good deal of chartering from one U.K. owner to another, some chartering of tonnage to and from non-U.K. nationals, and some operation by U.K. owners of vessels chartered by the U.K. Government from overseas countries. All these situations had to be sorted out and allowance made in the inquiry.

(*e*) Figures were collected for whaling factories and catchers, but they are omitted from this paper. Apart from the fact that only three companies were concerned and itemization of the figures might permit of the identification of individual companies, the whaling factories are in a special position because the "imports" which they produce have no country of origin.

* The General Council of British Shipping is a body formed by two partners, the Chamber of Shipping of the U.K., and the Liverpool Steam Shipowners' Association, which between them include among their members practically every shipowner in the country. It deals mainly with policy matters affecting the whole industry.

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22. It should be remembered that in designing the inquiry and in carrying out the subsequent analyses we had, without asking owners to do the impossible, to assess three different things:

(*a*) The gross earnings of the U.K. fleet.
(*b*) The contribution of U.K. shipping to the U.K. balance of trade.
(*c*) The movements of currency across the exchanges consequent on our shipping activities.

As concerns (*a*) the position was relatively straightforward, and it was not found difficult to deal with complications arising from the fact that in the course of the year U.K. citizens chartered some of their ships to overseas nationals and also chartered some ships from overseas nationals.

As regards (*b*), the main problem was to settle some systematic method of assigning freights to persons who are to be regarded as paying them. It is assumed throughout this paper that freights are a payment for services rendered to the purchaser of the goods carried, that is to say, that freights on U.K. imports are paid for by U.K. citizens and freight on U.K. exports or on goods carried on cross voyages are paid by non-U.K. citizens in the country of destination.

As regards passage money, distinction should have been made, under ideal conditions, between fares paid by U.K. citizens and fares paid by non-U.K. citizens, since it is only the latter which contribute to our earnings of foreign exchange. We had, however, to be content with information concerning passage money according to the country of collection of the money, this in general being the only item known to the shipping companies; and in default of more precise information it has been assumed that passage money collected abroad was all paid by non-U.K. citizens, and that collected in the U.K. was paid by U.K. citizens. I do not think that the error involved in this assumption can be very appreciable.

As regards movements across the exchange, there were two complications. First, the shipowner does not always know what is the actual currency which ultimately pays a freight—he may be paid by a sterling draft on a London House, although the merchant or some other party has had to convert that sterling from another currency. For this reason the inquiry asked whether freight was payable on loading or on discharge, and in the analysis it was assigned to the currency of the country of origin or destination respectively. Second, owing to the lag in the receipt and payment of bills the overseas receipts and expenses of shipping attibutable to 1947 do not necessarily correspond exactly to the volume of currency passing through the exchanges in that year. So far as freights were concerned, owners were asked to apportion to 1947, on a time basis, voyages overlapping at either end of the year, but this was not always possible for disbursements. However, in the majority of cases any end-effects at the beginning and the close of the year should cancel out in the aggregate, and the results should be a good approximation to the actual operations within the calendar year 1947, although, as I say, they may not exactly correspond to transactions through the exchanges.

23. The main results of the inquiry are presented in Table 18, together with some comparative figures for 1936. The effective fleet in 1947 was 14,510,000 gross tons, which includes vessels chartered from non-U.K. nationals and vessels chartered abroad to non-U.K. nationals. It earned a total gross sum of £373·7 millions. Of this, no less than £153·0 millions, or 40·9 per cent., was spent as disbursements abroad. Of the remaining £220·7 millions, £142·3 millions is attributable to freight on imports, and £18·1 on passage money collected in the U.K. The balance, namely £60·3 millions, is the net earning in foreign exchange on the above-mentioned assumption that passage money collected abroad was paid by foreign nationals and that collected in the U.K. was paid by U.K. nationals.

24. To avoid misunderstanding I interpolate one remark at this point. The inquiry purposely did not ask for disbursements in the U.K. Interesting as that item would have been, it was not relevant to the inquiry, the work on which had to be kept to a minimum. In consequence we cannot determine how much of the balance of £220·7 mns. (gross receipts of £373·7 mns., less foreign disbursements of £153·0 mns.) remained in owners' hands after payment of running expenses in the U.K. for the purpose of meeting depreciation, taxation, management expenses, the cost of post-war reconditioning, the payment of dividends and so forth.

25. In my paper (1948*a*), already referred to, I discussed the form of account appropriate to the shipping services of the U.K. mercantile marine, and for 1936 estimated the net earnings as £24 mns., which is comparable to the above figure of £60 mns. for 1947. Table 19 is an account for 1947.

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TABLE 18.—*Summary of the Results of the Invisible Exports Inquiry for* 1936 *and* 1947

	1947	1936
Effective gross tons	14,510,000	15,100,000
Receipts:	£ *million*	£ *million*
Freight on imports	142·3	50·8*
,, ,, exports	58·5	25·6*
,, ,, cross voyages	131·2	41·7*
Total freight	332·0	118·1
Passage money collected in U.K.	18·1	9·7
,, ,, ,, abroad	16·8	12·7
Total passage money	34·9	22·4
Charter hire	6·8	—
Total receipts	373·7	140·5
Disbursements abroad:		
Fuel	34·9	
Canal dues	6·6	
Other (mainly port dues and charter hire)	111·5	56·0
Total disbursements abroad	153·0	56·0

* Estimated from a 73 per cent. sample of complete returns.

TABLE 19.—*Shipping Services Account of the U.K. Mercantile Marine for* 1947

Expenditure abroad	£ *mns.*	*Income*	£ *mns.*
Fuel	34·9	Freight on exports	58·5
Canal dues	6·6	,, ,, cross voyages	131·2
Port dues, charter hire, etc.	111·5	Fares by non-nationals in U.K. ships	16·8
Balance	60·3	Charter hire	6·8
	213·3		213·3

It shows the earnings in foreign exchange *of the U.K. fleet only*, including deductions for hire paid by the U.K. Government or private shipowners for non-U.K. ships, and additions for hire received in chartering ships to non-U.K. nationals. I have assumed, for the purpose of this account, that bunkers taken abroad represent a disbursement in foreign currency. This seems to me the correct method when we are forming an account of the activities of the fleet operated by the U.K. It may not correspond exactly to the actual movements of currency across the exchanges in 1947 because bunker oil taken abroad may be paid for in the U.K.

26. In comparing 1947 with 1936, we must remember that in 1947 a proportion of the fleet was engaged in troop-carrying, which reduced its commercial earnings. The following figures, based on freight and disbursements abroad per gross registered ton of ships actually trading give, perhaps, a better basis of comparison:

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TABLE 20.—*Freight and Disbursements Abroad per Gross Registered Ton in* 1936 *and* 1947

	£ *per g.r.t.*			
	Freight		*Disbursements abroad*	
	1947	1936	1947	1936
Passenger and passenger/cargo liners	25·37	7·87	15·67	4·85
Cargo liners	31·48	10·09	11·45	5·01
Deep sea tramps	20·80	5·96	5·66	2·33
Tankers	18·42	6·83	4·81	2·31

In this table the division between cargo and other liners is not very exact. The invisible export inquiry did not allow us to itemize the figures for individual ships, and the classification into "passenger and passenger/cargo liners," for example, really relates to "companies whose vessels are predominantly passenger and passenger/cargo liners." The classification is nevertheless sensible, if only because in the great majority of cases a company owns only vessels of one of the four types. The earnings of passenger and cargo liners were, of course, higher than the figures given in this table because it relates to freight earnings. For 1947 the receipts per gross registered ton, if passage money is included, are £38·91 for passenger and passenger/cargo liners, and £32·17 for cargo liners. There are no comparable figures for 1936.

27. Now we come to the problem of relating these results to the Government's White Papers, which give for 1947 a net shipping earning of £24 mns. The Government's figure relates to dry cargo ships only, freights on oil being taken as part of the oil account; passenger fares by U.K. nationals in foreign ships are included in the "travel" item; and the account is, of course, a balance on National shipping service, covering several items which are not within the scope of the U.K. inquiry, such as freight on imports in foreign vessels and disbursements of foreign ships in U.K. ports. Table 21 attempts to arrive at the balancing figure on the basis of the invisible export inquiry and such estimates as I can make. I must emphasize that the figures marked with an asterisk are not on the same sort of foundation as the other figures given in Tables 18 and 19, and can only be very approximate.

TABLE 21.—*Estimated Dry Cargo Shipping Services Account (including Foreign Ships) for the U.K. in* 1947

Expenditure	£ *mn.*	*Income*	£ *mn.*
Freight on imports in foreign vessels*	47	Freight on exports in U.K. ships	58
Disbursements of U.K. ships abroad and hire for chartering foreign ships	124	Freight on cross voyages	91
Passenger fares by U.K. nationals in foreign ships*	5	Port expenditure of foreign vessels in U.K. ports*	22
Balance	17	Fares by non-nationals in U.K. ships	17
		Hire earned by charter of ships to foreigners	5
	193		193

* Rough estimates.

Before my figure of £17 millions is compared with the Government estimate of £24 millions we must add back £5 mns., being passenger fares paid by U.K. nationals in foreign ships, and make some allowance for the fact that a considerable proportion of bunkers taken abroad are paid for in sterling. I cannot translate the difference into figures, but it can be accounted for by errors of estimation on both sides, different time periods and special Government financial shipping settlements which fell in 1947.

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28. I am afraid that there is no royal road to a quick understanding of this rather confusing subject, and the layman is constantly being puzzled by the various figures quoted as our "shipping earnings."

Perhaps I may summarize the position very briefly:

(*a*) Let us first consider the gross earning of the U.K. fleet irrespective of the currencies, domestic or foreign, in which they were earned. The inquiry then shows that in 1947 the gross earnings of vessels operated by U.K. shipping companies (whether owned by them or chartered from abroad), together with hire of vessels which they chartered to non-U.K. nationals, amounted to a gross sum of £373·7 mns. Of this amount £153·0 mns. was spent in charter hire and disbursements abroad. The Invisible Exports Inquiry does not tell us how much of the remaining £220·7 mns. was spent in port disbursements in the U.K. or in other operating costs, such as wages.

(*b*) Of the gross income of £373·7 mns. a sum of £160·4 mns. was paid by U.K. citizens in the form of freight on imports and passage money collected in the U.K. The balance of £213·3 mns. less £153·0 mns. of disbursements abroad leaves £60·3 mns., which is the net contribution of U.K. shipping to our invisible export trade and represents a true net earning of foreign exchange.

(*c*) £60 mns. is not the figure which appears in the shipping items in the Government's White Paper (cmd. 7793), because the Government is concerned with dry-cargo shipping as a whole (whether domestic or foreign) in the service of the U.K. After allowances have been made for tanker freights, disbursements of foreign ships in U.K. ports, freight on imports in foreign ships and special settlements in 1947, the Government's net figure becomes £24 mns.

(*d*) Finally, comparison with the pre-war position is complicated, so far as concerns official figures, by the fact that before World War II the Board of Trade valued our exports f.o.b. and our imports c.i.f. so that the difference between the two included freights paid on imports. Since the war imports and exports have both been valued f.o.b., and freight on imports carried in U.K. ships no longer appears in the balance of payments statements or in the contribution of U.K. shipping to the invisible export side of the account.

29. Corresponding to the official figure of £24 mns. for 1947 the Government gave £20 mns. for 1938. I cannot give a figure for that year; but corresponding to my £60 mns. for 1947 the figure for 1936 was £24 mns. Both these are the contributions to invisible exports of the U.K. mercantile marine itself.

30. I may be reproached for unnecessary temerity in attempting Table 21, but the figures are perhaps worth displaying, if only to focus attention on the doubtful elements. I dare not go further and try to produce a similar statement for 1948. All the same, some estimate of the U.K. contribution for that year, corresponding to the £60 mns. for 1947, should be made.

The Government's figure for the shipping balance for 1948 is £57 mns., comparable to £24 mns. in 1947. The difference, namely, the increase of £33 mns., is probably firmer than either of the two figures themselves, which are net figures with large sums on either side of the account. The earnings of the U.K. fleet were higher in 1948 than in 1947, but there would have been less expenditure on chartering non-U.K. vessels, so that the increased contribution for U.K. dry cargo ships may have been about the same figure, say, £35 mns. Adding something for tankers (but not much because of the decline in tanker freights in 1948) we might estimate the increase in the contribution of U.K. shipping at about £40 mns., so that in round figures the contribution in 1948 was about £100 mns. In 1949 it may be a little higher, but the course of freights over the last half of the year makes this very uncertain.

The Geographical Distribution of U.K. Shipping Earnings

31. In a previous paper (1949) I have given a summary of the distribution of freight earnings by geographical area, and it is convenient to repeat the data in Table 22. These figures give a fair idea of the distribution of our shipping interests over the surface of the globe, but they do not, of course, correspond either to the volume of cargo moving from the named areas in U.K. ships or to the *net* earnings of the fleet in terms of foreign currencies.

32. From the Board of Trade returns for 1947 it is possible to compare column (*a*) of Table 22 with the value of goods imported into and exported from the U.K. from or to the areas mentioned *in all vessels irrespective of nationality*. The comparison is made in Table 23.

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TABLE 22.—*Geographical Distribution of Freight Earnings of U.K. Ships in* 1947.

*Area**	(*a*) *Voyages between U.K. and area named* (%)	(*b*) *On cross voyages beginning or ending in areas named*† (%)	*Total* (*a*) *and* (*b*) (%)
1. America	24·0	11·9	35·9
2. N. Europe	4·6	4·9	9·5
3. Mediterranean	6·2	4·6	10·8
4. Africa	7·0	2·2	9·2
5. Asia	9·6	10·9	20·5
6. Oceania	9·5	4·6	14·1
Total	60·9	39·1	100·0

* "North Europe" includes France, the Baltic and Scandinavia. "Mediterranean" includes Spain and Egypt. "Africa" excludes the Mediterranean countries. "Asia" includes Malaya and Japan.

† This item covers freight payable on discharge or on shipment in the area named, *i.e.* for cargo moving from area A to area B the freight was assigned to A if payable on shipment and to B if payable on discharge.

TABLE 23.—*Column* (a) *of Table* 22 *Compared with Proportionate Value of U.K. Imports and Exports*

Area	*Proportion of freight earned by U.K. vessels between U.K. and area named.* (%)	*Proportionate value of goods* (%)
1. America	24·0	21·0
2. N. Europe	4·6	11·9
3. Mediterranean	6·2	4·6
4. Africa	7·0	7·0
5. Asia	9·6	9·8
6. Oceania	9·5	6·6
Total	60·9	60·9

In constructing the last column of Table 23 I took the total value of imports and exports and converted them proportionately to figures which would add to 60·9, the total of the middle column. The features which stand out are the relatively higher freights on voyages to and from Oceania and the relatively lower freights on voyages to and from North Europe—both being reflections, of course, of the relative lengths of haul, and probably also of the different proportions carried in U.K. ships to different areas. Before we can compare the average freights per unit value of cargo we shall have to wait for the Board of Trade's returns of imports and exports by nationality of carrying flag, which I understand are in course of preparation.

33. Isserlis, in his 1938 paper, gave an analysis of U.K. carrying trade and earnings by route between the U.K., Empire and foreign countries. What he called "Empire" I must now call "Commonwealth" and to preserve comparability I still include Eire in it, if the Irish will forgive me. (If they will not they may derive some comfort from the reflection that the figures would be much the same if they were treated as foreigners.)

To give a statement for 1947 comparable to that for 1936, however, I have had to take a slightly different approach from Isserlis in certain respects, which accounts for the fact that the figures below in Table 24 for 1936 differ slightly from his.

(*a*) The following figures relate only to freights, that is to say, passage money has been excluded.

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(*b*) Net freights have been determined by subtracting from gross freights items of expenditure abroad incurred in port, but expenditure *en route* (*e.g.* canal dues) has not been deducted. The reason for this is that the liner returns for 1947 gave disbursements abroad only by country of incurrence, not by route. They were distributed over routes in proportion to the freight paid on loading and discharge in each country, but this method could not be followed for *en route* expenditure.

(*c*) The 1947 figures cover only freight and disbursements of ships engaged in commercial trading. The earnings of troop transports have been omitted.

TABLE 24.—*Distribution of U.K. Freights in* 1936 *and* 1947. (1936 *Figures Based on* 11·1 *mn. Gross Tons and* 1947 *Figures on* 13 *mn. Gross Tons of Shipping*)

UC, from U.K. to Commonwealth countries; CU, from Commonwealth countries to U.K.; UF, from U.K to foreign countries; FU, from foreign countries to U.K.; CC, from one Commonwealth country to another; CF, from Commonwealth to foreign countries; FC, from foreign to Commonwealth countries; FF, from one foreign country to another.

	1936		1947	
Route	*Gross freights* (%)	*Net freights* (%)	*Gross freights* (%)	*Net freights* (%)
UF	8·0	8·3	8·1	9·3
FU	18·4	21·8	22·2	25·4
UF + FU	26·4	30·1	30·3	34·7
UC	13·5	15·5	9·7	9·9
CU	24·5	27·0	21·0	22·6
UC + CU	38·0	42·5	30·7	32·5
CC	6·8	2·4	7·6	4·6
CF	7·0	5·5	6·3	4·5
FC	6·2	4·4	10·6	9·0
CF + FC	13·2	9·9	16·9	13·5
FF	15·6	15·1	14·5	14·7
Total	100·0	100·0	100·0	100·0

34. On the basis of gross freights it will be seen that trade between the U.K. and foreign countries was somewhat greater in importance in 1947 than in 1936, the increase arising on imports into the U.K., which perhaps might have been expected. Trade between the U.K. and the Commonwealth was relatively a good deal lower in 1947, trade between the Commonwealth countries slightly higher; and correspondingly trade between the Commonwealth and foreign countries was considerably higher. Trade between foreign countries remained about the same, but was slightly lower.

Taking into account the transformation in world politics and economics between 1936 and 1947 it is perhaps a little surprising that the pattern of trade, as far as it is shown by these figures, was disturbed to such a small extent. We might well have expected bigger differences in the FF trades. On the other hand, the fall in the relative importance of U.K.-Commonwealth trade (though it does not necessarily involve a decline in absolute volume of trade) appears to be signifi-

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cant, notwithstanding that the Commonwealth in 1947 (for the purpose of the analysis of these figures) excluded Burma and Palestine.

Acknowledgments

35. Once again I follow Dr. Isserlis, who at the conclusion of his paper paid a warm tribute to his colleagues at the Chamber of Shipping and particularly to Pleasance Bray for their help. I cannot speak too highly of the value of Mrs. Bray's assistance in the Invisible Exports Inquiry, and, indeed, in all my work at the Chamber of Shipping. I relied on her from start to finish, and it is mainly due to her unfailing patience and skill that the inquiry was brought to a successful conclusion.

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Discussion on Professor Kendall's Paper

Mr. H. Leak: It gives me the greatest of pleasure to move a vote of thanks to Professor Kendall for his excellent and extremely interesting Paper. It is a worthy successor to that presented by Dr. Isserlis twelve years ago, and the Society is much indebted to Professor Kendall for the present contribution on his leaving the shipping for the academic world.

I have always had a great interest in shipping because for the first nineteen years of my service in the Board of Trade I was in the Mercantile Marine Department; then I was transferred to the Statistics Department and became responsible for the statistics of the industry, so that I have always been closely associated with it. It is with very real pleasure, therefore, that I welcome the new tables which analyse the composition of the U.K. merchant fleet. This is information that has been sadly lacking in the past. Some fragmentary particulars are given in *Lloyd's Register* and in the *Annual Statement of Navigation*, but we have not had before that most important division between liners and tramps.

I would like a little more information about the Shipping Freight Index. My first inquiry is with regard to the method of dealing with missing quotations. Dr. Isserlis used a method which I criticized on the last occasion; when a quotation was not available he dropped that route entirely out of the index, and in one month that action caused the index to sag by 7 per cent., and in the next month it recovered by 5 per cent. Professor Kendall has not mentioned anything about methodology, but perhaps he could tell us how he tackled that problem.

My next request is for two additional tables. Professor Kendall has mentioned that the freight index for 1948 relative to 1938 is 330. It would be of considerable interest to have the dispersion of freights about that figure. He says that freights were very much on the level, but I think we ought to have information about the groups in addition to the overall index. If timber freights, for example, had risen more than the others, it might partially serve to explain the rather high weighting that Professor Kendall has obtained for 1948. The second table, which I feel is very important, though it will occupy several pages in the *Journal*, is information about the actual quotations on the various routes in 1948. Dr. Isserlis gave us all the quotations on his routes in 1935, and when a new base year is being established—and may I say how entirely I agree with Professor Kendall's choice—it is important to have on record the basic data. It enables others to do sums if they wish to, and it will enable a comparison to be made with Dr. Isserlis's figures. I would also suggest to the compilers of the new Index that they give monthly the freight indices on the different routes as well as the overall freight index so that we can see whether timber, or whatever it is, is responsible for changes in the index; and the annual average of the quotations should also be given.

Professor Kendall has based his calculations on quantities of the various kinds of bulk cargo carried in tramps. That is all right as applying to the weighting of the groups, but I am wondering how he has used that method for the weighting of the separate quotations. Frankly, I am puzzled. We do not, for example, know how much coal went on each of the routes between the United Kingdom and France, which is all recorded as an export from this country to France.

Discussing Table 16 Professor Kendall explains that the marked fall in the proportion for grain is due to the 1935 weights being based on freights and the 1948 weights on tons, and grain having a

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relatively high freight. One might assume from that that the weights given for 1948 were tons, but that is not the fact. Imports of grain in 1948 were 6·7 mn. tons, and exports of coal and coke 11·4 mn. tons. The 1948 weight for grain is higher than that of coal, so Professor Kendall has multiplied the tons weight by a freight, as one would expect, and in each year the figures represent the proportion of the gross freight that is earned in the carriage of these different kinds of goods.

I want to be rather bold and make a suggestion for an alternative method of weighing. Before doing so I wish to refer to the point Professor Kendall made in his summary about the publication entitled *Nationality of Carrying Vessels*. We have not got the information available for 1948 yet, but we hope it will be published next year. I have received some of the figures for 1947, but I do not propose to quote them because it was such an abnormal year. The pre-war publications show that the proportions of the various cargoes in British ships were, approximately, coal 47 per cent., grain 67 per cent., timber 20 per cent., iron ore 40 per cent. These percentages vary so widely that they largely account for the differences in weighting which Professor Kendall has found in 1948 in relation to 1935. The only firm figures as a basis for weighting the index are those given by Dr. Isserlis, which were actual figures of freight earnings on different routes, and unless and until we have something of the same kind of information again I suggest that we should use these figures as a basis, and modify them according to the various factors which affect it.

There are three variables; the first is the proportion of the total weight of imports represented by the various classes of goods imported into the United Kingdom; the second is the proportion of those goods which are carried in British ships, and the figures for nationality of carrying vessels will enable us to correct for that factor, so that next year we should be able to get those two factors correctly weighted; the third is the cross trades. I am afraid I do not know whether there is anything buried (or otherwise) in the Ministry of Transport which would give information about what was done on the cross trades in 1948 or thereabouts, but as Professor Kendall has not used it I must assume that the information is not available. It is rather important to know what happened to the cross trades, not only because of the volume of goods which were carried, but because freights on those routes may have moved differently from freights to and from the United Kingdom. If they have that might account for a larger proportion or a smaller proportion going to cross routes, but if we get the figures for which I have asked about the individual quotations for 1948 it would enable that kind of cross analysis to be made, and it might be illuminating.

Professor Kendall mentioned that I criticized the weighting for grain in Dr. Isserlis's index. That was done because he boosted the figure of £7·5 mn. up to £12·4 mn. by a lot of additions, some of which, for example, timber not to the U.K., not from Russia, of over £1 mn., were quite inappropriate. I would suggest that the compiler of the index should first consider what modifications are needed in Dr. Isserlis's base weights before accepting them as a firm basis on which to work. One further point; I think it would be very much better to have the weighting in units and not to indulge in decimal points, which cannot have any effect on the final index.

I have left very little time to deal with the final section of the Paper, but I would like to say two things. As the official primarily responsible for the invitation to make the first two inquiries into shipping earnings, I am extremely grateful for the new addition to our knowledge of this very difficult subject which Professor Kendall has provided. The inquiries since the start have improved greatly in two respects, first of all in the nature of the investigation that shipowners were asked to make into their earnings with a view to getting better results, and in the response of the shipowners to the request for information. The result on this last occasion has been outstanding and we really must congratulate Professor Kendall on that, and also express our most grateful thanks to the shipowners for being so willing to provide time and labour for the purpose of getting out this information, which is of such great importance to everyone.

Professor Kendall mentions that he has collected figures for whaling factories but has omitted them from the Paper. I think that detracts quite appreciably from the value of the results. Imports from these factories are recorded under whale fisheries, and included in the Continental analysis under Oceania. That makes the figures for Oceania in Table 23 not quite correct and, more seriously, the figure of £60·3 mn. in Table 19 is too high; it should be reduced by the disbursements of the whaling companies abroad.

The three subjects that Professor Kendall has dealt with are of very great importance, and the Society should be grateful to him for adding to our knowledge in this way. It has involved an enormous amount of work. I now propose that he be accorded a very hearty vote of thanks.

Mr. L. A. Bullwinkle: It gives me very much pleasure to second the vote of thanks to Professor Kendall. We are all most grateful to him for the many contributions he has made to the subject of shipping statistics during the all too short period he has spent at the Chamber of Shipping. To myself and my colleagues who have been associated with him in the Invisible Exports Enquiry

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and in other matters he has proved to be a tower of strength, and has given a lead to the shipping industry which has met with a very generous response.

With regard to the first part of the Paper and the new shipping statistics which he has furnished, it is most helpful to find that there is now a more selective machine to give details not previously provided officially. I should like to mention one or two minor points in relation to them. In para. 5 attention is drawn to the fact that the war-time building accounted very largely for the abnormal number of tramps at the 7,000 gross tonnage figure. This comment can also be directed to the same size group amongst the foreign-going liners, since liner companies have to a large extent found it necessary to re-establish their fleets with war-time products of similar types.

In dealing with the age distribution of the fleet Professor Kendall has remarked on the distortion due to war-time and post-war building, and this is emphasized when one realizes that the figures shown of the tonnage built in the pre-war years by reason of war losses are only about half what they otherwise would have been. The volume of tonnage of twenty years of age and over is, however, relatively high, owing to the need during the past few years to retain vessels in service as long as possible pending replacements. This difficulty has been felt acutely in the case of passenger vessels. In so far as shortages of particular types of tonnage remain in evidence, and both liner and tramp operators have to make do with the standardized war-time product, there will probably be an urge to build as soon as prices and other conditions permit. Before these conditions are established, however, there may well be an interregnum of years in which the volume of building is subnormal.

In the matter of size and speed distributions there are, of course, some figures available in the *Annual Abstract of Statistics* issued by the Central Statistical Office. The latest figures for dry cargo, excluding passenger vessels, show that the proportion of tonnage under 10 knots has fallen from 26 per cent. in 1939 to 11 per cent. in 1948, while in the speed group 14½ knots and over the proportion has increased from 9 to 20 per cent.

Coming to the part of the Paper which probably interests us all very much, the Invisible Exports Inquiry, it may be within the recollection of some of you that in March, 1947, in the discussion on Dr. Snow's Paper, Professor Kendall made some forecast of the income of United Kingdom shipping for 1947 in the terms in which it was the practice to calculate it before the war. The pre-war figure (1936) was £75 mn., and in contrast to that Professor Kendall hazarded a guess that the 1947 figure might be £200 mn. The inquiry which has more recently been undertaken gives a figure of £202 mn. These figures give a fair measure of the earnings of British shipping, and the £202 mn. figure I might perhaps explain consists of the figure of net earnings of foreign exchange £60 mn. and of freight on imports £142 mn. The facts are much more clearly set out in Table 18 of the Paper.

Para. 22 poses problems which had to be answered in relation to the United Kingdom tonnage effectively trading in 1947. It is worth noting that at the beginning of that year the tonnage included approximately 2½ mn. gross tons of vessels on bareboat charter from America, but that figure decreased rapidly throughout the year. At the same time, however, the volume of United Kingdom owned tonnage in commercial services, including tonnage restored from war services, was increasing at a somewhat greater rate. 1947 was a difficult year for this enquiry.

With regard to the difficulties in calculation of passage money, it has been possible to make some examination by means of passenger statistics which distinguish between United Kingdom residents and others and also between United Kingdom and other vessels. These calculations only tend to confirm the validity of the assumptions which have been made in the paper.

The third problem, the movements of currency across the exchanges, was quite new to the shipping inquiries undertaken by the Chamber and Council, and the results are shedding new light on the significance of certain aspects of exchange control.

I found Table 20 to be of particular interest. The comparison of freight per gross ton, 1936 with 1947, and disbursements per gross ton in each of these years is set out, and invites one to indulge in a certain amount of arithmetic, and even to extend the field of comparison to embrace freight indices and indices of wholesale prices. One may be tempted to deduce more from the figures than the circumstances warrant, but I think it is worth noting in relation to tramps (1) that 1947 and 1948 figures of freights show increases over pre-war which are materially greater than increases in wholesale prices, and (2) that the freight increase has been materially greater than the increase in disbursements.

These results were perhaps to be expected so long as the special risks and conditions to which shipping was subject during the war continued to influence the level of freights. The more recent fall in freight rates shown by the author's tramp freight index, however, goes a long way to show that the position is being reached in which freight rates are in what may be described as more normal relationships to both wholesale prices and disbursements abroad, that is, relationships not very different from those obtaining before the war.

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I hope these remarks will not be construed to imply that there will be no further fall in freight rates. The position reached may not be unhopeful, but the shipping industry in common with its ships is open to the full strains and stresses of conditions wherever they may be found.

I will conclude my remarks by saying that judging from the comments which the opener has made he realizes that with regard to Table 23 the comparison which the table invites is not wholly valid in the absence of information as to the proportion of goods carried in United Kingdom vessels.

Sir WILLIAM ELDERTON asked Professor Kendall if he would in the course of his reply indicate exactly how insurance was dealt with in the statements towards the end of his Paper. Perhaps he could indicate why he thought it was advisable by putting two hypotheses, both of which were extreme. If all marine insurance were done in a foreign market there would be a lot of foreign cost of insurance. If all marine insurance were done in the United Kingdom market a contribution to balance of payments would have to come in somewhere. It might be that for shipping it was not very important, but it must be remembered that the contribution of insurance generally to balance of payments was considerable. As an invisible export it was very large, and it did not need imports to get it. It was not largely made up of marine insurance, it was mostly fire and casualty insurance, but as an item in the accounts it was wise in a Paper such as this that it should be made quite clear how the item had been dealt with.

He felt that the figure which Professor Kendall gave showing the contribution of British shipping was a more satisfactory item from the point of view of the ordinary human creature than the lower figure given by the official statement. He did not mean to suggest that the official statement was incorrect, but what one wanted to know was what particular industries were contributing, and that was the figure which Professor Kendall had given. If one merely gave the net result of "contribution by British shipping" less the corresponding cost of foreign shipping a different question was being answered, and it was one which from the point of view of anybody engaged in any business in this country was singularly unsatisfying.

He agreed with the remarks made by the author on the remarkable achievement of the shipping industry in regaining the size of the fleet so soon after the heavy losses of the war. He was grateful to Professor Kendall and to the shipowners for having been so public-spirited in obtaining this information and allowing it to be published.

Mr. CAMPION drew attention to the figures in Table 18, where total freight earnings were divided into freight on imports, on exports (which presumably included re-exports) and on cross-voyages. Earnings on cross-voyages amounted to £131 million out of £332 million, or 40 per cent. of the total—a higher proportion than in 1936. He asked whether, in view of the importance of these estimates, Professor Kendall would describe in more detail how the split between these three categories was obtained. Did they mean that in 1947, 40 per cent. of the total freight receipts of British shipping was earned, not from carrying British exports abroad or carrying imports into the United Kingdom, but in carrying the goods of other countries to countries other than the United Kingdom?

There were at least two reasons for thinking Professor Kendall's figures were right. First, Table 18 related to the earnings of tankers and non-tankers. Tankers carry oil. The United Kingdom was not an oil-producing country, and therefore there could be very little in the way of receipts by tankers in taking British exports abroad. Indeed, a comparison between Tables 18 and 21, which related only to dry cargo shipping, showed that the earnings of tankers from exports was negligible, while earnings of tankers on cross voyages was about £40 million—the difference between £91 million and £131 million. Secondly, in 1947 exports of coal from the United Kingdom were low—much less than in 1936, and less than they were in 1949.

Mr. Campion asked whether there was any possibility that only the first leg of a voyage of a vessel taking British exports to two or more countries on the same trip was counted as an "export," but the second leg of the same voyage was counted as a "cross voyage." He wanted to be sure how Professor Kendall's figures should be interpreted, since the impression might be that the growth of British exports since 1946 was not likely to have contributed so much directly to increasing the gross receipts of the shipping industry. If a much smaller proportion of the export trade of the United Kingdom was now being carried in tramps than before the war, it was more important in studying the effect on prices of British goods abroad to have figures of changes in liner than tramp rates.

Mr. A. S. CARRUTHERS wished to associate himself with those who had spoken in appreciation of this Paper. He knew something of the amount of work which had gone into it. There were three questions he would like to ask. The first related to Tables 13 and 14. Table 13 was a

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summary of Tables 1–12, and the total of gross tons was shown as 15,357,000. In Table 14 the total was shown as 15,823,000, a difference of 466,000, and it occurred to him that returnable tonnage accounted for the difference.

His second point referred to Table 15A, where the average size of vessels was shown in 1949 at 6,000 gross tons for tramps. In comparing this with 1939 it should be borne in mind that most of the war-built tramps were constructed as closed shelter-deck ships, with the result that a vessel which would have measured about 5,000 gross tons pre-war, in the post-war era was about 7,000 gross tons (if unopened), and it might be that the average of 6,000 gross tons was in fact somewhat less, and when compared with 1939 there might not be very much difference between the two figures.

Lastly, he would like to suggest that there should be a further column to Table 14 showing in 5-year age-groups the relevant percentages. For example, 56·8 per cent. of the entire U.K. Fleet was 10 years of age and under, and this would emphasize the point which Professor Kendall was making, viz. the problem in the future with regard to ship replacements. He thought the addition of these percentages would bring the position out more clearly than the cumulated percentages.

The following contribution from Dr. ISSERLIS was read by the Honorary Secretary:

I wish I could be present to hear Professor Kendall read his interesting paper and add my tribute in person, but I do not feel strong enough to face the 300-mile journey at this season. The paper is an admirable swan song. I wish to comment on three points. First I wish to congratulate him on the construction of a card index of trading merchant vessels. I hope it will be kept in being at the chamber notwithstanding its author's translation. Its immediate usefulness is shown by Tables 1 to 15, but the usefulness will be increased if a place is found for dead cards, so that records can be built up showing what becomes of vessels removed from the live index distinguishing marine losses, conversions, breaking up, sales to owners outside the U.K. and so forth. Such an account for all vessels on the register is included in G.R.128.

Secondly, I welcome the reappearance after a lapse of nearly ten years of an index number of shipping freights. Some of the necessary changes in the 1935 routes and cargoes tell a melancholy story. The omission of "*Cont.*" in the U.K. *cont.* groups indicates I suppose that our tramps now do little of the carrying from North and South America to the Continent. The reduction in our export trade in coal has also left its mark. As regards weights I am glad that gross freights have been retained even though they are 1935 totals. To replace them by cargo tons would nullify the main object of the index as a guide to the gross earnings of the tramp fleet. A ton of wheat carried from Australia to U.K. represents a bigger service than a ton of wheat carried from Canada, and for similar distances wheat contributes more than iron ore per ton. In fact, Kendall's explanation given on p. 19 shows, *pace* my old friend Leak's criticism, that gross freights are the correct basis. When fuller data are available a moving set of weights will be an advantage as Kendall suggests, so would a moving set of routes; in fact a chain index. In my 1938 paper I used 210 homeward routes as part of a comparison of freights in 1936 with those in 1869, but only 3 or 4 of the routes were common to the two years.

Thirdly, it is good to note that after an interval of 12 years it has been possible to conduct another inquiry into the contribution of shipping to invisible exports—an inquiry which Sir Walter Runciman in 1932 optimistically suggested the Chamber of Shipping should conduct yearly. The illustrations in para. 20 of the labour entailed in shipping offices, and Kendall's, Mrs. Bray's and my own experience of the labour involved at the Chamber should damp ministerial ardour. It is gratifying to note that the response to the 1948 inquiry covered 99 per cent. of effective tonnage. It may be of interest to ask how far this was due to ten years of total and partial control from Berkeley Square, and the consequent acquiescence if not enthusiasm of shipowners even in such recalcitrant areas as Liverpool in filling up forms. This would be an ungenerous interpretation of shipowners' attitude to statistics. The first inquiry in 1932 obtained replies covering 65·5 per cent. of effective tonnage. Five years later the 1937 inquiry obtained a 91·1 per cent. response. A simple if daring extrapolation would have led us to expect a more than 100 per cent. voluntary response in 1942 if there had been no war and no controls.

Coming to the general results of the inquiry, I confess that I am as puzzled as the "layman" of para. 28 by the various figures quoted as our "shipping earnings." I can understand the figure of £60·3 mn. for 1947 and, with an effort, Kendall's corresponding figure of £24 mn. for 1936. To obtain the latter figure he had to convert our 1936 imports from a c.i.f. to an f.o.b. basis. His task must have been even more difficult than that of the Board of Trade in dealing with current figures. I can remember the statistical hazards run by the U.S. Department of Commerce in determining the f.o.b. values of their imports by the search for a notional willing buyer and willing seller in a notional open market in the country of origin.

What I can't understand at all is why the Government's white paper limits itself to *dry* cargo, and so arrives at a figure of only £24 mn. for 1948. Most laymen will take this as a measure of

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the full extent to which the shipping industry helps to pay for our imports. Kendall's Table 20 suggests that 3 mn. gross tons of U.K. tankers performed carrying services to a net value of £39 mn. in 1947. A substantial part of this must have been for services performed for non-residents of the U.K. and helped to pay for our imports. It seems deplorable that figures tending to depreciate the contribution of seamen and shipowners to our net export trade should be given this official currency, while the gross figures of the exports of classes of manufactured goods are given great publicity without deducting their content of imported raw or semi-manufactured materials.

The following written contribution was received after the meeting:

Mr. C. H. SPRAY: I should like to add my meed of thanks to Professor Kendall for his very interesting Paper. I am sure the Society will appreciate how much labour and trouble have been put into it by him and his erstwhile colleagues at the Chamber of Shipping. We all know what a mass of detail may lie behind the most innocent-looking table.

It occurs to me that one or two points might be made a little clearer, and I am sure Professor Kendall will not mind my dotting one or two "i's." With reference to para. 2, it is not quite correct to say that the statistics of United Kingdom ships published by Lloyd's Register of Shipping cover all non-naval vessels on the United Kingdom Register, whether trading or not. Having been chiefly responsible for those statistics for very many years, I would state that the Tables are, and have been for the last 60-odd years, based on the entries in *Lloyd's Register Book*, which are limited, broadly speaking, to seagoing ships of 100 tons and upwards. There are, of course, very many ships on the United Kingdom Register which are of less than 100 tons and many which may be solely employed on rivers or canals or are yachts. *Lloyd's Register Book* does, however, include many harbour craft and all seagoing fishing vessels above the 100-ton limit. The entries in the *Register Book* do not—except in the case of oil tankers, tugs, trawlers, etc.—include definite indications as to the type of employment of a ship (e.g. as passenger liner, cargo liner or tramp), and it is therefore not practicable to show these latter distinctions in the figures.

I am a little disturbed also by the use of the somewhat ambiguous word "trading." Surely a fishing vessel may be regarded as trading, for it is neither a warship nor, as a rule, a pleasure craft. To use the terminology of the Insurance Acts, it is certainly a vessel which is "gainfully occupied," and I rather prefer the use further down of the description "in ordinary commercial employment."

Professor Kendall was, of course, in a favourable position to obtain his information from United Kingdom shipowners. It is, all the same, remarkable that he was able to receive replies covering 99 per cent. of effective tonnage. I wonder how far this is perhaps the outcome of the strict control to which the shipping industry in this country has been subjected in recent years. When one is dealing (as I deal) with shipowners all over the world, such a comprehensive response is by no means so likely.

I notice one or two slight inconsistencies in Tables 1 to 12 for which, doubtless, there are good reasons. For instance, while some are apparently based on ships of 100 tons and upwards, others have varying downward limits, such as 500 tons, "under 1,000 tons," etc. In another case, the rather unfortunate "1,600-ton" limit rears its ungainly head.

I have not had time to refer to Professor Kendall's previous papers which he quotes, and I would therefore like to ask whether the term "foreign-going" includes everything that is not coasting, or does it exclude ships engaged within the Elbe-Brest limits. The Size Tables do show what was, of course, known, namely, the preponderance of ships round about the 7,000-ton mark; while the Age Tables emphasize the magnitude of the war-time building effort, even though the figures represent only the surviving balance of the ships then constructed. The very great increase in the number and tonnage of oil-fired steamers since the outbreak of the war is also not unexpected. These changes have already been shown in Lloyd's Register's statistics.

Like Mr. Leak, I am not impressed by the omission of figures collected for whale-oil factories and whale catchers, especially not by the reason given "that the 'imports' which they produce have no country of origin!"

Regarding para. 6, with its somewhat pessimistic prospect of new construction for home account, I would suggest that not all ships remain on the British Register until they are worn out. We still sell quite a number of them to other countries, when permitted to do so, before their term of usefulness has expired.

In repeating my appreciation of Professor Kendall's Paper and the labour involved in its production, may I also (although anticipated by Dr. Isserlis) express the hope that this may not necessarily be the Professor's swan song in relation to statistics dealing with shipping matters.

Professor M. G. KENDALL (in reply): I am grateful to the contributors to the discussion for the careful way in which they have studied the paper and for the helpful comments which they make. As there are a number of points requiring reply, perhaps they will forgive me if I deal with them rather briefly.

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(1) Missing quotations: I followed the method used by Dr. Isserlis as described in his paper. It is not perfect, but after giving the matter considerable thought I was unable to find a substitute. In fact, the problem of the missing quotation in index numbers is an extremely intractable one. So far as I can see, the only acceptable alternative would be to insert a "notional" freight when no actual quotations exist; but if such a freight is calculated according to the average of existing freights it makes no difference whether the missing quotation is inserted or not. Furthermore, as a practical point, it would be extremely difficult to convince shipowners that the index was a sensible one if, for example, we inserted imaginary freights in wheat from Montreal during the winter when everyone knows that the St. Lawrence is frozen up and that no cargo can move.

(2) Further tables: I hope Mr. Leak will excuse me from complying with his request. In order to meet it I should have to show the 1938 quotations for individual routes as well as the 1948 quotations, and as the index is only an interim one I doubt whether publication would be worth while, although no doubt the information could be made available to the Board of Trade if they wished to have it.

(3) The weighting of separate quotations: The 1948 weighting which I suggested was applied to test whether a new weighting was desirable and was applied only to the groups. For the separate quotations making up a group I used the original weights employed by Isserlis. There was at the time no information about quantities moving on individual routes.

(4) Mr. Leak's point about the 1948 weights: The figures I used were based on the U.K. Commodity Import Programme for the first half of 1948 and the test was made for the month of March, 1948. (It will be appreciated that I was carrying out these tests at the end of 1947 and the beginning of 1948 when the actual volumes of imports were not known and the volumes of exports could not be estimated.) It was my intention to use tons weight and not a weighting figure based on value.

(5) Weighting by cross routes: I fully appreciate that since the cross trades account for such a large proportion of the work of U.K. tramps it narrowed the field to base the weighting on U.K. imports and exports alone. This was one of the reasons why I reverted to Isserlis's original weights, although they themselves were based on freight earned and not on tons of cargo carried. There is a point of difference here between Dr. Isserlis and myself, since he prefers weights based on gross freights, whereas I prefer weights based on tons. Where to obtain suitable material for tonnage of cargoes for any new index which may be prepared in a suitable future period is a problem which has not yet been tackled.

(6) Whaling factories: My own opinion is that "imports from British whale fisheries" are not really imports at all, although they are shown as such in the Board of Trade returns. In fact, whale oil from British fisheries seems to be on a par with other home catches of fish, both being obtained by the operation of U.K. capital and labour. The only difference is that in whale fishing, as Mr. Leak remarks, certain foreign disbursements are incurred.

My own figures purported to show (and I think correctly show) the contribution to our balance of trade due to the operation of vessels engaged in the commercial carriage of goods and passengers. If the whaling operations were included the disbursements abroad would be increased by about £1·9 million. There would be little offsetting earning of foreign exchange, but the actual value of the whale oil brought in in 1947 was nearly £9 million.

(7) Passage money: I was interested and relieved to note Mr. Bullwinkle's comment that an examination of passenger statistics which he has been able to make confirms the assumptions made in the paper.

(8) Freight levels: Mr. Bullwinkle points out that the freights for 1947 and 1948 show increases over pre-war which are materially greater than increases in wholesale prices, and that the freight increase has been greater than the increase in disbursements. Against this it should be stated, (*a*) that I doubt whether the index of wholesale prices is a good basis of comparison. The index for 1948 on the basis of 1938 = 100 was 216. On the other hand, average values of exports in 1948 on the same basis were 247 and of imports in 1948 were 291, and I think these are better figures for comparison with freight levels; (*b*) the disbursements referred to are foreign disbursements which are mainly port charges, and there tends to be a lag in such charges behind a general rise in costs. I have no comparable figures for disbursements in the U.K., but, since wages and fuel costs account for a very high proportion of them, they are undoubtedly relatively higher than the foreign disbursements.

(9) Insurance: As regards Sir William Elderton's comment, which I assume relates to the insurance of vessels (and not of cargo, which would not enter into this enquiry at all), the answer is that nearly all marine insurance is done on the U.K. market and therefore would not appear in the enquiry, being a disbursement in the U.K. In one or two cases where a company insured abroad, the cost was taken as a foreign disbursement and any insurance recoveries counted as receipts; but the amounts were very small indeed.

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(10) Division of cross voyages: Mr. Campion is correct in suggesting that the figures mean that in 1947 40 per cent. of the total freight receipts was earned in traffic between countries other than the U.K. As regards Mr. Campion's similar point about the "leg" of a voyage, any cargo going out from this country to a foreign country was counted as an export, even if there were intermediate calls; so that, for example, if a liner left the U.K. to discharge cargo at Gibraltar, India and Australia, the returns distinguish these items, which are all shown as exports. Any cargo picked up at a foreign port and carried to another foreign port would be shown as a cross voyage.

(11) Total tonnages in Tables 13 and 14: The difference to which Mr. Carruthers calls attention is due to the fact that in Table 14 I estimated the 1949 figure by adding something for new buildings to the end of the calendar year, whereas the earlier tables relate to the middle of the year.

(12) Mr. Carruthers is quite correct in making his point about closed shelter-deck ships. Some of them had been opened by the middle of 1949, but there may have been others which had not, and to that extent the average size of 6,000 gross tons for tramps may be on the high side. Time alone will show whether this is the case.

(13) I was very glad to have a contribution from Dr. Isserlis and accept his comments. As regards his suggestion about dead cards, I understand that this is being followed at the Chamber.

(14) Definition of vessels on Lloyd's Register: I accept Mr. Spray's correction on this point. I fear that the statement in the paper is an over-simplification of a rather complicated position, though I hope it is not misleading in its context.

(15) Definition of trading: I hope it is clear from the context of the paper that in speaking of trading vessels I am referring to those engaged in the commercial carriage of goods and passengers, but I agree with Mr. Spray that the word "trading" is not a very good description. It would be useful if we could find some short phrase which would express this idea and would not cover fishing vessels and tugs which, I agree, are trading in a sense and even in the same sense "in ordinary commercial employment."

(16) Tonnage limits in Tables 1–12: As Mr. Spray suggests, there were good reasons for the slight inconsistencies in the lower tonnage limits in Tables 1–12, so many of the ranges over the bottom of the table being empty for certain classes of shipping. For the sake of uniformity, however, this matter is being put right in future tables of the same kind to be published by the Chamber. The 1,600 ton limit used in paragraph 10 was imposed on us by the fact that I was using pre-war figures, but I fully share Mr. Spray's opinion that this is a limit which ought to disappear in post-war figures, and in fact I have not used it.

(17) Definition of foreign-going: Mr. Spray is correct in saying that this phrase includes everything that is not coasting or engaged within the Elbe-Brest limits.

(18) Sale of ships abroad: Mr. Spray is quite correct in suggesting that in pre-war days we used to sell quite a number of secondhand ships. The industry would certainly have wished to do so in the post-war period and might have earned quite a lot of foreign exchange by doing so; but the fact is that it was prevented by the Government, except in a small number of cases, from selling ships abroad at all. I hope these restrictions will be removed as soon as possible.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Jane Adair.
J. A. Bailey.
L. E. Barnard.
J. A. Bound.
G. R. Burgess.
J. D. Butler.
Mary Davies.
D. J. Day.
A. T. Dunn.
J. C. Gangulli.
A. Glaskin.
N. K. Hartrey.
E. D. Jennings.
J. Knowelden.
E. F. Livesey.
A. Lubin.
B. H. Mehta.
Cynthia Mogford.
Freda Moshkowitz.
M. D. Moustafa.
A. R. Munden.
J. A. Pope.
A. F. Purser.
G. R. Reah.
K. F. Sanjana.
T. E. Shrimpton.
J. V. Smith.
P. Stevenson.
A. E. Tate.
R. E. Walpole.
L. P. Walsh.
Iris E. Williams.

Corporate Representative

E. E. Bullus, *representing* the London Municipal Society

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The Sources and Nature of Statistical Information in Special Fields of Statistics

United Kingdom Labour Statistics

By R. B. Ainsworth, C.B.E., M.C.

The systematic collection of labour statistics began just over 60 years ago in pursuance of a Resolution of the House of Commons. The task was originally entrusted to the Board of Trade, but in 1917 the responsibility was transferred to the Ministry of Labour. It is not proposed to relate the history of the collection of labour statistics; suffice it to say that the main subjects on which statistics have been compiled have been in principle the same throughout the period. There have, of course, been very great developments in their nature and scope, and for many years there have been some subjects within the category which have been handled statistically by other Departments. In one important respect, however, there has been a gradual change. The opening paragraph of the first issue of the *Labour Gazette* in 1893 reads as follows:

> "The *Labour Gazette* is a journal for the use of workmen and of all others interested in obtaining prompt and accurate information on matters specially affecting labour."

It may be inferred from this that the primary purpose of the statistics was to provide general information. This purpose has been maintained so far as publication in the *Gazette* is concerned, but the statistics now collected are very largely those required as a basis for administrative action, for the testing of the effects of such action, and as a basis for Government economic policy. The statistics published are those which become available from the information collected for these purposes. This is not to say that the volume of statistics available to the public has been adversely affected. On the contrary, there has been for many years a driving force behind the collecting of statistical information which has resulted in a very great increase in the statistics published by the Ministry of Labour and available in the *Gazette* and elsewhere for general consumption.

Some account of the labour statistics compiled and published by the Ministry of Labour and National Service, and by other Departments, is given in the following paragraphs. The main purpose of these paragraphs is to provide a background for the detailed study and use of the available figures, and to indicate some of the main pitfalls which attach to these as to many other series of statistics. The review does not cover the large number of studies of labour statistics which have been made by research institutions and private research workers, many of which have formed the basis of papers read before the Society.

Employment

The statistics compiled by the Ministry of Labour and National Service as to the size and constitution of the working population are based primarily on the numbers of persons covered by the social insurance schemes. The counting of such persons is rendered possible by the fact that the contributions to the schemes are payable by means of stamps affixed to the cards of individuals, and that periodically these cards have to be renewed. In the process of renewal the old cards can be classified in various ways, e.g. by sex, industry, locality, etc., and counted. This procedure gives a good deal of information on a comprehensive basis relating to the working population.

Before 1948 the cards used for this purpose were those of persons insured against unemployment. The sickness and old-age pension cards were not so used, since the procedure of exchange was almost entirely in the hands of the separate Societies. The radical change in the coverage of the scheme in July, 1948, however, resulted in a break in the continuity of the figures derived from the old unemployment insurance scheme and in an extension of the field covered by the statistics. The figures, therefore, can be reviewed in four parts, viz. (*a*) the numbers insured under the unemployment insurance schemes up to June, 1948; (*b*) the numbers insured under the national insurance schemes since July, 1948; (*c*) the estimates of total manpower (men aged 14–64, women aged 14–59) made during the period 1939–48 on the basis of the figures in (*a*) above and returns received from employers; and (*d*) the new series of estimates of total manpower aged 15 and over, based on the figures in (*b*) above and employers' returns.

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(a) *The numbers insured under the Unemployment insurance schemes up to June*, 1948.—The scheme of unemployment insurance was first started in 1911, but up to 1920 it covered only a relatively small proportion of the working population. In the latter year, however, the scheme was extended to cover the very great majority of manual workers and a large proportion of non-manual workers. Some further changes in the scope of the scheme were made in subsequent years. Persons aged 65 and over ceased to be insured in 1928 when they became entitled to pensions under the contributory scheme. Boys and girls under 16 became insured in 1934, agricultural workers in 1936, private gardeners in 1937, and certain classes of domestic workers in institutions in 1938. Women aged 60 and under 65 ceased to be insured in 1940 on becoming entitled to contributory pensions, and, finally, the income limit for the exception of non-manual workers from insurance was raised from £250 a year to £420 a year in September, 1940. Throughout the period the scheme excluded employers and workers on their own account and also certain classes of employees, the principal of which were indoor private domestic servants, teachers with pension rights, female professional nurses, police, established civil servants, and permanent employees in national and local government and in railway service. Women who took up part-time employment during the war were also excepted from insurance.

Statistics of the numbers of persons insured under the limited schemes in operation before 1921 were compiled every year and were given in various publications, including the successive issues of the Abstract of Labour Statistics. Estimates of the numbers insured under the extended scheme are available for every year from 1923 to 1948.* Throughout the period separate figures were compiled for every age-group for which there were separate rates of contributions, and the insured population for each year was analysed into about 100 industry groups on the basis of a scheme of classification which was closely related to the classification used for the 1921 Population Census. Code Letters representing the classification of the insured person's industry were written on every unemployment book at the time of issue and at the middle of each year at the time of the annual exchange, and a count of the number of books bearing the same Code Letters therefore provided a satisfactory basis for estimating the insured population on the industry classification which the Code Letters represented. Fuller details, particularly about the age-distribution of insured persons in each industry, were obtained from time to time by analysing small random samples of unemployment books.

The following Table shows the estimated total number of insured persons in Great Britain since 1923. The two lines of figures for 1927, 1935, 1936, 1937, 1938, 1940 and 1941 show the effects of the changes in the scope of the scheme. The decline in 1943 to 1945 was, of course, due to the exclusion of persons in the Forces.

July	*Thousands*	*July*	*Thousands*
1923	11,232	1937 (*a*)	14,885
1924	11,404	1937 (*b*)	14,991
1925	11,623	1938 (*a*)	15,154
1926	11,774	1938 (*b*)	15,395
1927 (*a*)	11,876	1939	15,548
1927 (*b*)	11,534	1940 (*a*)	14,842
1928	11,629	1940 (*b*)	14,803
1929	11,834	1941 (*a*)	14,562
1930	12,138	1941 (*b*)	14,922
1931	12,500	1942	15,061
1932	12,543	1943	14,630
1933	12,620	1944	14,150
1934	12,690	1945	13,640
1935 (*a*)	12,780	1946	15,200
1935 (*b*)	13,708	1947	15,550
1936 (*a*)	13,980	1948	15,760
1936 (*b*)	14,580		

* The Unemployment insurance schemes came to an end at the middle of 1948 and were superseded by the new National insurance schemes. When counting the numbers insured under the latter schemes, however, arrangements were made for obtaining separate figures of the numbers previously insured under the old Unemployment insurance schemes in order to maintain comparability with previous years.

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Analyses of these figures by Regions and by industries have been published in the *Ministry of Labour Gazette*, and analyses by Regions and industries combined have been published separately in "Tables Relating to Employment and Unemployment" in respect of the years 1939, 1945, 1946, 1947 and 1948.

It may be mentioned that, owing to delay in exchanges, account was taken of all cards of the previous year's currency exchanged between July and September, and minor adjustments were made, on the basis of past experience, for cards which might be exchanged after September. Adjustments were also made in respect of persons whose cards have been lodged at Employment Exchanges for some time and whose employment status was not known.

(b) *Numbers insured under the National insurance schemes since July*, 1948.—In July, 1948, the unemployment insurance scheme (as well as other social insurance schemes) was superseded by the comprehensive National insurance scheme under the National Insurance Act, 1946, and the National Insurance (Industrial Injuries Act), 1946. Under this scheme an insurance card must be held and contributions paid at one or other of the prescribed rates in respect of every person* employed under a contract of service, irrespective of age, occupation, and the number of hours for which the person is employed in the week. Contributions are also payable by employers and self-employed persons, with the exception of those who had reached pensionable age before the scheme came into operation and married women who exercise the right to "opt out" of the scheme.† In 1948 contribution cards were issued to persons insured under the new schemes by the Local Offices of the Ministry of Labour and National Service, and on the basis of the counts of cards issued, estimates were made of the numbers of employees insured under the schemes, analysed to show (*a*) the numbers who were previously insured under the unemployment insurance scheme, and (*b*) the numbers who were not previously insured against unemployment. The former figures enabled comparability to be maintained with previous years, while the two sets of figures combined provide the starting-point of a new series of statistics of employees on the comprehensive basis. The total number of employees under the new schemes at mid-1948 was 20,500,000, compared with 15,760,000 under the old scheme.

A count was also made of the number of cards issued to employers and self-employed persons, but the total was lower than had been anticipated. It was fairly clear that at the date of the count many such persons had not actually registered.

The introduction of the new national insurance schemes coincided with another major change, viz. the adoption of a new basis for the purpose of classifying insured persons by industry. This was the "Standard Industrial Classification" which had been prepared by an inter-Departmental Committee for the use of all Government Departments. It provides for separate figures for nearly 170 industry groups, compared with about 110 in the classification previously in use. It also differs from the old classification in other important respects. Estimates were made of the effects of the changes on the figures for mid-1948, and a Table was published in the April, 1949, issue of the Ministry of Labour *Gazette* giving an analysis on the basis of the *old* industrial classification of the numbers at mid-1948 who were previously insured under the Unemployment Insurance Acts. These figures are directly comparable with those published for previous years.

For administrative reasons it was not found practicable after mid-1948 to arrange for an annual exchange on one date of the cards of all the persons insured under the National insurance schemes. Arrangements were therefore made for cards of different colours, marked A, B, C and D, to be issued on a random basis, and for all cards of the same colour to be exchanged in future at quarterly dates, beginning in March, 1949. There are, thus, now available random 25 per cent. samples at the end of each quarter. These samples are sufficiently reliable to give aggregate figures of the number of insured persons, but not detailed analyses of the numbers of employees by industries and localities which are required for purposes of town and country planning and in connection with the location of industries. It was further arranged, therefore, that in June, 1949, and possibly in future years, employers of five or more persons should make returns showing the total number of cards held by them. These returns are being classified by industries, and it is anticipated that,

* The only exception to this rule is that the contributions for permanent Civil Servants are paid in bulk without affixing stamps to cards. The number of persons in this class, however, is known and can, therefore, be added to the number of insurance cards in use.

† Contributions are also payable by certain classes of non-employed persons, but hey are outside the scope of this article.

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in conjunction with the count of cards actually exchanged in June, they will form a satisfactory basis for a detailed analysis. The estimated number of self-employed persons and employers will rest solely on the 25 per cent. sample. It may be noted that the distinction between employers and self-employed will be based on the value of the last stamp on the card exchanged in cases where the status of the individual has changed during the insurance year.

The insurance cards are now actually exchanged at Local Offices of the Ministry of National Insurance. Arrangements have been made, however, under which the statistical returns are compiled by an associated Local Office of the Ministry of Labour and National Service. The tabulation and analysis of the figures remains the responsibility of the latter Ministry.

(c) *Estimates of total working population*, 1939–1948 (*males aged* 14–64, *females aged* 14–59).—During the war it became necessary, for the purposes of manpower planning, to make estimates of the total working population of insurable age. The primary basis was, of course, the series of statistics of the numbers insured under the Unemployment Insurance Acts, but those figures had to be supplemented by estimates of the numbers in the various classes of uninsured employees and of the numbers of employers and workers on their own account. For this purpose use was made of all available sources of information, such as the Ministry of Agriculture annual returns of agricultural workers, the annual Railway Staff Census, the quarterly returns of Government employees, etc., and the Population Census of 1931. In estimating the numbers of employers and workers on their own account use was made of the statistics derived from the last Census of Population. In many cases, however, the available information was far from complete, and in those cases the additions for the uninsured element in the working population were only approximations. Separate estimates were made for males and females in each industry for which separate figures of insured persons were compiled. Indoor private domestic service, however, was excluded from the series throughout the period.

Estimates of the total working population, as described above, were made for mid-1939 and for the middle of each year from 1941 to 1947 by adding the estimates of the numbers of uninsured employed persons to the numbers of insured persons and the numbers in H.M. Forces. It was realized early in the war, however, that information as to the changes in employment, particularly in the industries that were important in the war effort, would be required at more frequent intervals, and the Government accordingly obtained compulsory powers for requiring employers to render returns. Quarterly returns covering the munitions industries were instituted in 1940, and half-yearly returns covering the textile, clothing and certain other manufacturing industries were instituted later in that year. An arrangement for obtaining returns from a "sample" of employers in the distributive trades, catering and certain other services was also made in 1942. This arrangement for obtaining returns from employers has been continued after the war, and the scheme since 1945 has been as follows:

(*a*) Monthly returns from all employers with more than 10 workpeople in manufacturing industries, with additional details every third month.

(*b*) Monthly returns (in simpler form than the returns rendered by manufacturing firms) from a sample of employers in the distributive trades, the catering industries, entertainment and sport, laundries and cleaning, road transport and certain other services. The same returns are also rendered by all employers with more than 10 workpeople in the electrical wiring and contracting industry.

(*c*) Quarterly returns from Local Authorities.

Each return showed the numbers employed at the beginning and end of the month, with separate figures for the numbers over insurable age (65 for men and 60 for women). The ratio between the numbers of insurable age at the beginning of the month and the end of the month for any industry was adopted as the measure of the rate of change in employment during the month. The rate of change thus obtained for the month of July was applied to the mid-year estimate of the number of insured persons in employment, and the figures thus calculated were adopted as estimates of the numbers employed at the end of July. The process was repeated month after month, and a series of monthly estimates of employment was thereby established for the industries covered by the returns. Use was made of all other available sources of information for the purpose of making corresponding estimates for the industries that were not covered by returns from employers; these sources included, for example, the weekly statistics of employment in

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coal mining compiled by the Ministry of Fuel and Power, the monthly estimates of employment in the building and civil engineering industries made by the Ministry of Works, information as to the number of teachers obtained from the Ministry of Education, etc. Estimates of the numbers of part-time workers who were not insurable under the Unemployment Insurance Acts were made on the basis of the employers' returns and other data, and they were included in the figures on the basis of two counting as one unit. As regards employers and workers on their own account, there was little direct information about the changes from month to month, and the figures that were adopted were merely estimates of the probabilities. In these various ways estimates of the total working population of insurable age were compiled for every month between mid-1945 and January, 1949, and the figures were regularly published in the *Ministry of Labour Gazette* and the *Monthly Digest of Statistics*. The industrial analysis of the figures was based on the classification in use before July, 1948 (i.e. the same classification that was used for analysing the estimates of insured persons, as described in (*a*) above). It may be noted that the opportunity has been taken to include in the employers' returns certain information other than that required as a basis for the estimates of the working population. This has included the proportions of operatives and of technical, clerical and administrative workers, the number of part-time workers, forecasts of future requirements, and particulars as to the number of discharges and engagements during the month. The latter figures are now used for the monthly statistics relating to the extent of labour turnover. During the war information was also asked for with regard to the numbers employed on work for different Government Departments, for export, and for the home market. It may be mentioned that the monthly returns are rendered by employers through the Local Offices of the Ministry of Labour. They thus provide, not only national statistics, but they also enable the Local and Regional Offices to keep a close eye on developments in the labour position in their own areas.

(d) *Estimates of total working population, mid-1948 and onwards (aged 15 and over).*—With the introduction of the new National insurance schemes in July, 1948, the scope of the estimates of the total working population was altered to conform with the scope of the insurance schemes. The effect of the change was that the new series of estimates included men over the age of 65 and women over 60, and also indoor private domestic servants, who were excluded from the earlier series. Moreover, the new series is analysed industrially in accordance with the Standard Industrial Classification, which, as stated in Section (*b*) above, was introduced simultaneously with the new insurance scheme.

So far as employees are concerned, the compilation of the estimate of the total working population does not involve any addition to the estimate of the number insured under the scheme, as described in Section (b), once every employee is insurable.

Employers and workers on their own account are also insurable, but in 1948, when the first estimates in the new series had to be made, it was clear that it would take a considerable time for all persons in this class to realize their obligations under the scheme and to obtain their insurance cards. The count of insurance cards issued during the first few months of the operation of the scheme could not, therefore, be relied upon as a basis for estimating the total number in the class, and an approximate estimate was accordingly made, mainly on the basis of the numbers liable to pay Income Tax under Schedule E. This estimate of the numbers of employers and workers on their own account must, of course, be regarded as provisional, and subject to revision in the light of later statistics derived from the exchange of insurance cards.

In view of the approximate nature of the statistics relating to uninsured workers and self-employed persons before mid-1948 (referred to in the first paragraph of (c) above) it was not altogether surprising to find, when a more comprehensive count became available, that the working population before mid-1948 had been somewhat under-estimated. A description of the new working population figures was given in the *Ministry of Labour Gazette* for February, 1949.

The statistics derived from the mid-1948 count of the numbers insured are being kept up-to-date on a monthly basis by the same methods as those used before that date (referred to in (c) above).

Unemployment

Since 1921 the statistics of unemployment have related to the numbers of persons registered at Local Offices of the Ministry of Labour as unemployed on a specified Monday in each month.*

* In 1943–44 and the first nine months of 1945 the figures were compiled at quarterly dates.

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The numbers have been analysed by age and sex and in the categories wholly unemployed, temporarily stopped, i.e. suspended from work on the understanding that they were shortly to return to their former employment, and casuals. The totals have been separated as between insured and uninsured workers, and at various dates the emphasis has been changed, from the total figure to the insured, and vice versa. Until October, 1945, emphasis was placed on the total number of insured and uninsured combined. From October, 1945, onwards the emphasis was changed to the insured workers only. This change was made mainly because the uninsured consisted largely of boys and girls who had just left school and had not yet entered industry. Since July, 1948, when all employed persons became insurable, the only figure available has been that of all persons on the registers.

The figures generally used for comparative purposes over a series of years are those relating to unemployed insured workers. These have been subject to breaks in continuity arising from changes in the method of counting the numbers on the registers. In September, 1937, the following change was made in the method. Before that date all persons actually on the registers on the Monday of the count were included. From September, 1937, the system was changed, and all persons who, during the subsequent week, were found to have been actually in employment on the Monday, even though their books remained lodged at the Employment Exchange, were excluded. Up to December, 1938, the figures related to persons who were maintaining registration at the Exchanges, together with those who had ceased to do so within the preceding two months but were not known to have found work. From January, 1939, the latter category were excluded. From January, 1941, the figures excluded persons who had been classified as unsuitable for ordinary employment. This practice continued till January, 1948, when the system of classifying in this way by interviewing panels was dropped, and from that date only persons registered under the Disabled Persons (Employment) Act who were unsuitable for ordinary employment were excluded.

The following Table shows the total number of insured persons registered as unemployed at July in each year since 1937, and in the months when changes in the scope of the figures were made. In the latter case the two sets of figures represent the numbers unemployed counted on the old basis and the new, the differences being those described above.

	Thousands
July, 1937	1,419
September, 1937 (*a*)	1,420
September, 1937 (*b*)	1,373
July, 1938	1,871
January, 1939 (*a*)	2,125
January, 1939 (*b*)	2,032
July, 1939	1,251
,, 1940	755
January, 1941 (*a*)	681
January, 1941 (*b*)	653
July, 1941	234
,, 1942	103
,, 1943	76
,, 1944	68
,, 1945	120
,, 1946	392
,, 1947	281
June, 1948 (*a*)	274
June, 1948 (*b*)	286
July, 1948	282
June, 1949	243

As with many other statistics, there are certain concealed pitfalls in the figures of unemployment. The figures relating to unemployed insured workers can be used in conjunction with the statistics as to the numbers of insured workers to calculate the percentage rate of unemployment in the country as a whole and in broad geographical regions, and by industries. The numbers of

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insured persons have, however, as shown above, only been available at yearly intervals, and the percentages could only be calculated by relating the numbers unemployed month by month to the insured number at a fixed date in the middle of the year or of the preceding year. In this connection it should be noted that the industrial coding of individual insurance books was that of the individual at the date when the book was last exchanged; it was not altered if the worker changed his industry before the next exchange. The industrial classification of the unemployed, therefore, was on the basis of the industry at the middle of the year or of the previous year. This system has recently been changed, and the unemployed workers are now classified to the industry in which they were last employed.

A further point to be noted is that workers normally register when unemployed at the Local Office nearest to their place of residence. On the other hand, the books of insured persons have normally been exchanged in bulk by the employers at the nearest Office to the place of work. The books exchanged under the national insurance schemes are being exchanged, again very largely in bulk, by employers at the Local Offices of the Ministry of National Insurance. The areas covered by these Local Offices are in many cases different from those covered by the Local Offices of the Ministry of Labour. For these reasons the calculation of local percentages of unemployment in particular localities may give completely fallacious results. Somewhat better figures can be obtained, however, by aggregating the numbers insured and the numbers unemployed in groups of localities wide enough to include industrial centres and the adjacent dormitory areas.

Special returns are obtained by the Ministry of Labour at intervals of three months showing the numbers of wholly unemployed persons, analysed according to the duration of their last spell of unemployment. At intervals of six months this analysis is combined with a detailed age analysis of the registered unemployed. Figures are also collected monthly showing the number of persons placed in employment by Employment Exchanges and the number of vacancies outstanding at the end of the period.

Wages and Hours

The statistics compiled by the Ministry of Labour and National Service relate—

(*a*) to recognized standard or minimum rates of wages and normal weekly hours; and
(*b*) to weekly and hourly earnings and hours actually worked.

So far as rates of wages and normal hours are concerned, the information is derived in the main from voluntary collective agreements between organizations of employers and workpeople, and from Orders issued under the enactments which provide for the fixing of minimum rates, the Wages Councils Act, the Agricultural Wages Act and the Catering Wages Act. The extent to which minimum rates of wages are fixed under these agreements and Orders for different classes of workers in the industries concerned varies considerably. In some cases only the minimum rate for the lowest paid class is fixed, while at the other extreme rates are fixed for a wide variety of occupations. Usually the normal hours are uniform for all classes, though in some cases there are different hours for workers paid by the week and for those paid by the shift.

The information derived from the agreements and Orders is published annually in the *Report on Time Rates of Wages and Hours of Labour*. The annual publication began in 1946. Before that date publication was irregular—in 1893, 1900, 1906, 1909, 1912, 1913, 1915, 1920 and 1929. A summary covering the more important industries and districts was also given in the *Abstract of Labour Statistics* up to 1936. These Reports simply record the rates and hours and contain no derived statistics.

In the *Ministry of Labour Gazette*, however, information is regularly published giving details of the principal changes in rates of wages and hours of labour during the month, with estimates of the total number of workers affected and of the aggregate amount of the change in weekly rates of wages, and of the average change in weekly normal hours. These statistics are based on estimates of the number of workers affected supplied to the Department by the organizations concerned, in conjunction with the estimates of the total numbers of persons employed in different industries. On the whole they tend to understate the effect of the changes, since those arranged in the first place to cover the organized branches of the industries gradually spread in many cases to cover unorganized employers and workers. The monthly figures of numbers affected relate to

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those actually affected in the month, irrespective of whether the same workers have also had changes in earlier months. In aggregating the figures for successive months and for calendar years, however, workers are counted once only, irrespective of the number of times their wages were varied during the period. This adjustment is not, however, carried on from year to year. Thus although the amounts of change over several years can be aggregated to show the total increase, the number of workers affected cannot be so aggregated to produce a figure of the total number of individuals affected over a number of years. It will be realized that these statistics relate only to the effects of changes in recognized rates of wages and normal hours. They do not include the effect of increases or increments granted to workers by individual employers for various reasons, such as efficiency or upgrading. The figures do, however, include the effect of changes in piece rates of wages, provided the changes are granted without any change in the quality or quantity of the work performed.

This series of statistics has been running since 1893, but changes in its coverage have affected comparability over the period. At one time the figures did not cover agricultural workers, shop assistants, seamen, railway servants and Government employees, mainly owing to lack of information. All these classes, however, are now covered by the figures. But apart from these additions there has been a very marked increase in the number of workers covered by the changes, resulting from the development of collective bargaining and the operation of Statutory Orders. Before 1914 agreements were very largely local in character and covered only a limited number of areas. During the last thirty years, however, wage agreements on a national basis have taken their place, with the result that there has been a much greater degree of standardization in wage rates, and consequently a much wider coverage of the statistics.

The information derived from agreements and Orders has also been used as a basis for calculating index numbers of the movement of weekly wage rates. In these indices account has been taken not only of changes in time rates of wages, but also of changes in piece-rates of wages other than those resulting from changes in the nature or quantity of the work performed.

There has been an official index of wage rates since 1880. The first series, which was based on 1900 = 100, ran till July, 1914, and is available in the *19th Abstract of Labour Statistics*. This was followed by a series based on July, 1914 = 100, which continued till December, 1920, but a third series, based on 1924 = 100, was calculated back to December, 1920, and forward to 1939. This series was published in the *Abstracts of Labour Statistics* and, at quarterly intervals, in the *Ministry of Labour Gazette*. In 1935, however, a new index was calculated by the Director of Statistics in the Ministry of Labour, and given in a Paper read before the Society and in later supplements to the Journal. This was also based on 1924 = 100, and covered the period from December, 1920, to December, 1938. As this was on a wider basis than the *Abstract* series for the same period it is quoted in the Table below. From September, 1939, still another series, similar in construction to the previous one, was calculated by the Ministry of Labour with September, 1939, as 100. This series is available in the *Monthly Digest of Statistics* for July, 1947, and the *Ministry of Labour Gazette* for March, 1946, to July, 1947. This ran till June, 1947, when the present series, which regularly appears in the *Ministry of Labour Gazette*, was started, with that date as 100. The method of calculation of the last series is described in the *Ministry of Labour Gazette* for February, 1948. The following is a summary of the figures in the different series:

December, 1880, *to July*, 1914 (1900 = 100)

December, 1880	83·1
July, 1914	107·8

July, 1914, *to December*, 1920 (July, 1914 = 100)

July, 1914	100·0
December, 1920	275·0

December, 1920, *to September*, 1939 (1924 = 100)

December, 1920	154·8
September, 1939	104·6

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September, 1939, *to June*, 1947 (September, 1939 = 100)

September, 1939	100·0
June, 1947	166·5

June, 1947, *to present* (June, 1947 = 100)

June, 1947	100·0
December, 1949	109·0

On each occasion when a new series has been started the coverage has been extended and refinements made in the method of calculation. This, however, does not seriously impair the validity of linking the series to obtain a measure on a somewhat broad basis of the movement in weekly wage rates since 1880.

The information available with regard to earnings and hours worked is derived from returns collected by the Ministry of Labour and National Service from a sample of employers. These enquiries were made in 1886, 1906, 1924, 1928, 1931, 1935, 1938, July, 1940, and from July, 1941, onwards at intervals of six months, the dates being altered from January and July to April and October in October, 1946. The results of the first two enquiries were published in separate reports. From 1924 to 1935 the results were given in the *Ministry of Labour Gazette* for June, 1926, to September, 1927, October to December, 1929, January to March, 1933, and February to May and July, 1937. The average earnings shown by the 1938 enquiry were published in conjunction with those of later enquiries in the *Gazette* for August, 1944, and February, 1945. The figures derived from the enquiries since 1940 have been given in the *Gazette* about six months after the date of each enquiry.

The coverage of the enquiry since 1924 has been uniform. It has included the manufacturing industries and some of the more important non-manufacturing industries and services, but it has excluded coal mining, dock labour, the railway service, agriculture, shipping, the distributive trades, catering, entertainments and domestic service. Information as to coal mining, dock labour and the railway service so far as available, however, has been published on the basis of statistics collected by other Government Departments.

The enquiries of 1886 and 1906 were based on information supplied as to the earnings and hours of individual workers. Particulars were, therefore, available for separate occupations, and in regard not only to the averages but also to the distribution. The later enquiries, except that made in 1938, asked only for the total number of workers employed, distinguishing men, women, boys and girls, the total wages paid, and, except from 1940 to January, 1943, the hours worked. Consequently only average figures were available for each industry. In 1938 particulars were obtained in respect of individual workers without reference to occupation. Consequently the distribution of earnings and hours as well as averages are available. In publishing the results of the enquiries since 1924 the Ministry has given separate figures for each of the more important industries. The adoption of the new Standard Industrial Classification in 1948, however, resulted in some expansion of the details, but it impaired the comparison of the industry figures with those for earlier dates.

The sample of firms covered by the enquiries has differed from time to time. In 1938 the enquiries were sent to all employers with more than ten workers and to one-fifth of those with ten or less. The replies covered over 70 per cent. of the total number of employees in the industries concerned. Since 1938 the enquiries have been addressed to the firms which replied at that date and which have continued to render returns on a voluntary basis. In some industries, in which the sample was relatively small, however, additional firms have been included. Steps have also been taken to include important newly-formed firms. On the other hand, after July, 1940, many small firms in industries in which the omission of small firms had been found to have no effect on the averages were dropped from the list. The enquiries covered manual workers generally, and excluded clerks and office staffs, shop assistants and salaried employees generally. The total number of persons covered by the enquiries is about six million.

In order to calculate the average earnings and hours for groups of industries and for all the industries combined the figures for each industry have, since 1938, been weighted by the approximate number of workers employed by all the firms in the industry at the date of the enquiry. This has been necessary owing to the fact that the size of the sample varied in different industries.

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The figures, of course, reflect not only changes in the average earnings and hours over a period, but also changes in the proportions of workers employed in each industry and in the proportions of men, women, boys and girls. It may also be mentioned that the relationship between the average earnings in different industries is influenced to an appreciable extent by the varying proportions of skilled, semi-skilled and unskilled workers employed. The figures give no indication, therefore, of the relative level of earnings in different industries for work of a comparable character.

In recent years estimates of the total wages bill of the country have been made by the Central Statistical Office and published annually in the White Paper on National Income and Expenditure. These estimates are derived from a variety of sources. They include, in addition to cash wages, income in kind (food, lodging, etc.) of such classes as domestic servants, miners and farm workers.

Retail Prices

The fact that an index of retail prices is regarded as a section of labour statistics may appear to be an anomaly, especially as the compilation of the index of wholesale prices is a function of the Board of Trade. The explanation lies in the fact that the index has been calculated on the basis of prices charged to working-class households, and it has in varying degree been utilized as one of the factors in wage negotiations.

The first official index of retail prices (published in the *19th Abstract of Labour Statistics*) covered nine articles of food in London, and it ran from 1877 to 1900. Another series, running from 1892 to 1914 (also published in the 19th Abstract), covered 23 articles of food in London. From 1892 to 1900 figures for coal in London, and clothing and rent in London and other towns, were given, and these, as well as the food figures for London, were combined into a general index. From 1901 to 1914 only the food, clothing and coal figures were available.

In July, 1914, the series of cost of living index numbers which ran till June, 1947, on the basis of July, 1914 = 100, was started. A description of the method of compilation was given in the *Ministry of Labour Gazette* for February, 1921. During the first war, and for several years afterwards, the index was widely used in wage negotiations and as a basis for the automatic adjustment of wage rates under cost of living sliding scales. By the end of 1920 it had risen to 276, the wage rate index being about the same level. During the depression which followed the two indices ran very closely. By September, 1939, however, the wage rate index on the 1914 base was some 30 points above the cost of living index. By this time the latter index had become subject to criticism, largely owing to the fact that the pattern of expenditure in 1914 had become antiquated as a basis. Steps towards a new index had been taken in the shape of a Family Budget Enquiry in 1937–38. Further consideration of a revised basis was, however, interrupted by the war, and the index continued to be calculated as before. Although it was to a certain extent stabilized from 1941 onwards by the concentration of food subsidies on the items covered, wage rates continued to go ahead, and between September, 1939, and June, 1947, wage rates rose by about 66 per cent., compared with 30 per cent. in the cost of living index.

Early in 1947 a Cost of Living Advisory Committee, appointed by the Minister of Labour, decided that the series should be discontinued, and that as a temporary measure a new index should be calculated, using as a basis the pattern of expenditure shown by the 1937–38 budgets. The task of preparing a plan for the new index was entrusted to a technical committee. The recommendations of this committee were accepted, and the method of compilation of the new index which they formulated is described in Supplement No. 2 to the *Industrial Relations Handbook*. The weights applied to the price relatives of the various sections of the index correspond to the expenditure on the sections in 1937–38, adjusted to take account of the approximate changes in price up to the base date (June, 1947). The scope of the index is much wider than that of the old, and with minor exceptions it covers all the items of expenditure shown by the budgets. This means that, for a considerable number of items, no records were available of the prices paid by working-class households prior to the first collection of material for the new index in June, 1947. Consequently, no index numbers on a comparable basis could be calculated for earlier dates, and there is no official estimate of what the figure at June, 1947, would have been in relation to 1939 on the revised basis.

An index of personal expenditure on consumers' goods and services, calculated by the Central Statistical Office, is published annually in the White Paper on National Income and Expenditure. This is obtained by revaluing the current annual expenditure at 1938 prices. It is pointed out in

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the White Paper that the index is based on the total consumption of a changing population and not on consumption per head, and it is impossible to make full allowance for changes in the quality of goods and services. (In the retail prices index care is taken to omit changes in price which accompany changes in quality.) Nor is it practicable to make any deduction for the loss of satisfaction caused by obstacles to freedom of choice. It should be noted that this index relates to the total personal expenditure of the community, and it is not restricted to working-class households.

Family Budgets

Reference is made above to the enquiry into family expenditure of working-class households which was made by the Ministry of Labour in 1937–38. This enquiry covered a sample of households of manual wage earners and of non-manual workers with salaries not exceeding £250 a year. It related to expenditure in four weeks at quarterly intervals, beginning in October, 1937. The number of households which supplied four budgets suitable for tabulation was 10,396. In addition, 366 sets were collected through the National Federation of Women's Institutes. Of the total of 10,396, 8,905 were households the head of which was engaged in an industrial, commercial or clerical occupation, and 1,491 were those of which the head was in an agricultural occupation. In view of the wide variation in expenditure on clothing at different periods in the year, 2,100 of the industrial households were asked to supply a weekly return of expenditure on clothing throughout the year. This expenditure was slightly lower on average than the figure shown by the quarterly budgets for the whole of the households. The total expenditure of the industrial households, including the lower figure for clothing, averaged 85*s.* 1*d.*, of which food accounted for 34*s.* 1*d.*, housing for 10*s.* 10*d.*, clothing for 8*s.* 2*d.*, fuel and light for 6*s.* 5*d.*, and other items for 25*s.* 7*d.*

In the case of agricultural households, weekly clothing returns were supplied by 400 out of the total of 1,491. The average weekly expenditure, including that on clothing of the 400 households, was 57*s.* 4*d.* Of this, 27*s.* 9*d.* was spent on food, 4*s.* 9*d.* on housing, 5*s.* 3*d.* on clothing, 4*s.* 11*d.* on fuel and light, and 14*s.* 8*d.* on other items.

A description of the scope and method of the enquiries and of the results was given in the *Ministry of Labour Gazette* for December, 1940 (industrial households), and January, 1941 (agricultural households), while those received from members of the National Federation of Women's Institutes were summarized in the February, 1941, issue. The general summaries, together with analyses by Regions and by total expenditure groups, and specimens of the forms of enquiry, and the instructions to investigators, have been supplied in duplicated form to a number of Universities and research libraries.

Trade Disputes

For the purpose of statistics relating to trade disputes the Ministry of Labour takes account only of disputes which arise on the subject of working conditions and which involve a stoppage of work. It does not include in its figures any information with regard to stoppages which involve less than ten workpeople or which lost less than one day, unless the aggregate time lost exceeds 100 days.

The figures published are the number of disputes, the number of workers involved, including those thrown out of work at the establishments where the stoppages occurred though not themselves parties to the dispute, and the aggregate number of working days lost. The numbers involved are also analysed on the basis of the causes of the disputes, e.g. wages, hours, other working arrangements, etc. Particulars are also given in the *Ministry of Labour Gazette* of the dates, causes and results of the principal disputes in each month. The information is collected from the parties to the disputes.

The great majority of the disputes involve stoppages of short duration. In 1948, for example, out of the total of 1,759, 821 lasted not more than one day, and 1,625 lasted less than six days. The aggregate duration of the disputes has varied considerably in different years. During the years 1914 to 1918 the yearly average was 5,360,000 days. In 1919 to 1921 it was 49,140,000 days. From 1922 to 1932 (omitting 1926, when 162 million days were lost, mainly in the coal-mining dispute and the General Strike) the average was 7,560,000 days. Since 1932 the loss has

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been relatively small, and in the sixteen years from 1933 to 1949 the yearly figure ranged from 940,000 to 3,710,000.

It may be mentioned that the Ministry does not attempt to distinguish between official and unofficial disputes in these statistics, nor is it able to distinguish between strikes and lock-outs. In many cases the classification to one or other of these categories would involve an arbitrary decision.

Trade Union Membership

The Ministry of Labour publishes annually statistics of the total membership of trade unions. These statistics are more comprehensive than the membership of trade unions registered with the Registrar of Friendly Societies under the Trade Union Acts, or than the membership of unions affiliated to the Trades Union Congress which are presented to the Annual Congress. They include the membership of registered unions, together with those of unregistered unions, from which the Department obtains direct returns. So far as possible the membership is analysed by industry groups, but a complete analysis on this basis is impracticable owing to the fact that some of the largest unions have members in a variety of industries and no industrial analysis of their membership is available.

The statistics show, not only the aggregate membership, but they also analyse it according to the size of the unions. Out of a total membership of 9,301,000 in 1948, 17 unions, each with over 100,000 members, accounted for about two-thirds of the total, and 90, with a membership of over 10,000, accounted for 90 per cent. At the other extreme, 406 unions, each with less than 1,000 members, accounted for only about 1 per cent. The total membership in 1948, 9,301,000, was the highest on record. The highest total recorded before 1946 was 8,348,000 in 1920. The figure has grown fairly steadily from 4,392,000 in 1930. Of the total of 9,301,000, 7,632,000 were males and 1,669,000 were females.

Conclusion

This article has dealt in the main with statistics compiled by the Ministry of Labour and National Service. Reference has been made, however, to figures collected by other Departments which are utilized by the Ministry in order to avoid duplication of enquiries. There are, in fact, many supplementary statistics on labour matters in the publications of other Departments. For example, the reports on the Population Censuses contained analyses of the population by industries, occupations and industrial status; the reports on the Censuses of Production contained information with regard to numbers employed. The Ministry of Fuel and Power produces and publishes figures relating to numbers employed and earnings in coalmining. In the past the Ministry of Transport has compiled figures of numbers employed and earnings in the railway service. These figures, together with those relating to numbers employed in other sections of the transport industry, are now given in the Annual Reports of the British Transport Commission. The Agricultural Departments have their own figures of numbers employed in agriculture, and the Ministry of Works of those engaged in building. Figures of the numbers of teachers are put out by the Ministry of Education, and of persons in the Civil Service by the Treasury.

Bibliography

(NOTE.—It is impracticable to give anything like a complete list of publications in which labour statistics are to be found, but the following is a brief list of the more important of such publications. All these, except the *Year Book of the International Labour Office*, are publications of H.M. Stationery Office, but the earlier editions of some of them are out of print and are available only in University and other Libraries.)

Ministry of Labour Gazette (known at various dates as the *Labour Gazette*, *Board of Trade Labour Gazette*, and the *Ministry of Labour Gazette*), published monthly since March, 1893. An annual review of statistics of employment, unemployment, wages, prices and trade disputes has been given in the issues for January of each year.

Abstracts of Labour Statistics—1st to 22nd (latest publication 1937).

Reports on Wage Census of 1886 *and* 1906.

Reports on Standard Time Rates of Wages, 1893, 1900, 1906, 1912, 1913, 1915, 1920, 1929, 1946, 1947, 1948 *and* 1949.

Reports on Census of Population (*Industrial and Occupational Analysis of the Gainfully Occupied*).

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Tables Relating to Employment and Unemployment in Great Britain (*Regional and Industrial Analyses*), 1946 (with figures also for 1945 and 1939), 1947 and 1948.
Monthly Digest of Statistics (monthly since January, 1946).
Annual Abstract of Statistics, 1946, 1947 *and* 1948.
Year Book of International Labour Office.

A summary description of official labour statistics is contained in *Guides to Official Sources—No.* 1, *Labour Statistics*, also published by H.M. Stationery Office, in 1948.

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THE SOURCES AND NATURE OF STATISTICAL INFORMATION IN SPECIAL FIELDS OF STATISTICS

STATISTICS OF THE COTTON INDUSTRY

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Introduction

BEFORE the 1914–18 war the amount of statistical material available about the cotton industry was very limited. Between the wars there was some improvement, but it was not until after the 1939–45 war that the statistician could afford to pick and choose his material. The increased public consciousness of and demand for economic statistics, not only in this country but throughout the world, which the war brought as one of its less unpleasant consequences, is perhaps more apparent in cotton statistics than in any other field, and the contrast with earlier years is such that it appears convenient to deal with the subject in a chronological order.

Definitions

The boundaries between the cotton industry and other branches of the textile industry are not sharply defined. Some overlapping takes place with wool, linen and silk as well as with rayon; not only do some mills process fibres and yarns of these materials as well as cotton, but to a limited extent the same machinery may on occasions be changed from one fibre to another. Another source of overlapping is mixture cloths, where for example the warp threads may be of one textile fibre and the weft threads of another.

Many attempts to define the boundaries have been made, and the most important is contained in the Cotton Industry Development Council Order 1948. In this, each section of the cotton industry (spinning, doubling, weaving, finishing, making-up and packing and converting) is defined separately, and parts of the definitions of spinning and weaving in particular may usefully be quoted here:

"Spinning" means the production from fibre of single yarn containing not less than 95 per cent. by weight of cotton fibre (including waste from whatever process arising), staple rayon fibre (not exceeding 3 inches in length, but including waste rayon fibre), or a mixture of those fibres.

"Weaving" means . . . the production on looms connected with mechanical power of fabrics containing not less than 85 per cent. by weight of yarn produced by spinning or doubling or continuous filament rayon thread or a mixture of such yarn and such thread. . . . Providing that weaving shall not include the production of lace, lace net, lace curtains, fishing net, embroidery or narrow fabrics (not exceeding 18 inches in width). . . .

These, therefore, give precise though somewhat arbitrary limits to the cotton and rayon content of products of the cotton industry. These limits are, of course, observed in all the statistics collected under the powers conferred on the Cotton Board by the Order, which are described below. The Census of Production, before the war, followed a different principle. There, the term "piece goods of cotton" included only goods made wholly of cotton yarn; fabrics containing any proportion of rayon, however small, were included, for example, in the heading "fabrics of artificial silk mixed with other materials." In the 1948 schedules for the Census of Production mixture fabrics have been dealt with in some detail.

More fundamentally, the Census of Production classifies industries according to the preponderant activity of the individual establishment, whereas the definitions quoted above are based on the individual machine. Thus for Census of Production purposes a mill producing 40 per cent. cotton fabrics and 60 per cent. wool would be treated as part of the woollen industry, but

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under the Development Council Order the cotton part of its activities, including the machinery and employees engaged thereon, would be part of the cotton industry.

Units

Raw cotton is most usually recorded in terms of bales; this is an unsatisfactory unit to the statistician, because not only is there a more or less random variation in the weights of individual bales, but also there is a difference in standard bale weights used in the cotton-growing countries. In the United States, for example, bales are usually made up to approximatey 500 lb. gross weight, representing about 490 lb. net weight, in Egypt the standard bale weight is 730 lb., in India 420 lb., and there are further variations in other countries. There is a further cause of variation in bale weights which can be even more dangerous to the incautious; in years of heavy crops there is a tendency for the average bale weight to increase because of the efforts made to increase the volume of cotton passed through the presses.

Wherever possible it is desirable to express raw cotton statistics in terms of weight, and factors for converting bale weights are usually available. For example, before the war the Liverpool Cotton Association published every year a set of figures giving the average weight of bales imported from the various countries during the year. Before the war it was most usual to take the pound (lb.) as the unit of weight, but during the war the influence of shipping space restrictions on raw cotton statistics collected made the ton (of 2,240 lb.) the most common unit in this country.

Yarn is almost universally measured in terms of pounds (lb.). The only qualification here is that yarn weights should always be measured after conditioning, because yarn comes off the spindle dry and gains anything up to 10 per cent. by absorption of moisture when exposed to a normal atmosphere. Nearly all published statistics relating to yarn do in fact refer to the conditioned weight.

The best unit of measurement of cloth is the square yard; ideally, both the square yardage and the weight would be given. Many published figures, however, are quoted in linear yards because of the greater ease with which figures can be compiled in this unit, and although the difference between linear yards and square yards of cotton cloth is not large, it is sufficient to cause trouble. The average of all cloth produced in this country can with sufficient accuracy for many purposes be converted from linear yards to square yards by adding 10 per cent. For example, the average width of all cloths recorded in both units in the Census of Production for 1937 was 40·1 inches; the average width of all cloth exported in 1935–39, however, was 34·5 inches, and in 1948, 35·8 inches. Conversions from one unit to the other thus need care, and each must be treated on its merits. Between production and consumption of cloth the dimensions can change in two ways. Some cloths are woven in double width, particularly for export, the cloth being split during some stage of finishing; thus one yard produced may be two yards exported. Secondly, many finishing processes produce a shrinkage, mainly in the width but sometimes in the length as well. Splitting the width would affect the width and length of cloth but not the area; shrinkage may affect all three. The finishing processes frequently affect also the weight. Splitting and shrinking combine to explain most of the difference between the average widths of cloths produced and cloth exported.

The only other unit which may cause difficulty is that of the spinning spindle. There are two main types of spindle used for the production of cotton yarns, the mule spindle and the ring spindle. The ring spindle is comparatively a modern machine, and the bulk of the spindles in the Lancashire cotton industry are mule spindles. The problems of production with mule and ring spindles are very different, and it is in practice impossible to make direct comparisons between, for example, the production per hour of a mule spindle and a ring spindle. It is customary in Lancashire to express ring spindles in terms of mule equivalents by taking two ring spindles as equivalent to three mules, which expresses fairly accurately on average the relative productivity of the two types. This convention persists although there is now little justification for it, especially when comparisons are made with other countries where ring spindles predominate. A more logical convention would be to express spindles in terms of ring equivalents. With this reservation, however, the number of spindles is a very convenient and reliable measure of the machinery installed in the spinning section of the cotton industry. Careful distinction must always be maintained between the cotton spindle and the waste spindle, used for spinning either cotton waste

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or very low quality cotton. There are several types of waste spindle, but always the productivity per spindle is much higher than with cotton because of the comparative coarseness of the yarns produced. On the weaving side the number of looms is usually taken as the measure, but it is less perfect because of the greater variety in types of loom. The principal distinction is between the ordinary Lancashire loom and the automatic loom (i.e. a loom fitted with an automatic weft-replenishing attachment). The automatic loom is several times more expensive and, therefore, represents a greater capital investment; its rate of production of cloth is the same as that of the ordinary loom, and its advantage lies in the smaller amount of labour required to operate it. In the various branches of the finishing section of the industry the machine unit is less useful as a measure of productive capacity than in spinning or weaving. A possible exception is in calico printing, where the number of printing machines would be a good unit. No statistics relating to printing machines are, however, published for this country.

Nineteenth Century

Statistics relating to the cotton industry during the nineteenth century and earlier are very scanty. There is no direct information on production, but a fairly good index can be obtained from the official figures of raw cotton imported. These are available back to the start of the official import and export returns in 1696 (see A. Maizels, "The Overseas Trade Statistics of the United Kingdom"), and a useful extract going back to 1800 is given in the "Survey of the Textile Industries" (10).

Figures of exports of cotton goods from the United Kingdom are similarly available from an early date, by countries of consignment. These figures are most valuable in tracing the rapid development of the industry, concentrated as it largely was on the export field, during the nineteenth century. A useful feature of the early years of the trade accounts is that although statistics of exports of cotton goods are available by value only until 1820, the use of lists of official valuations, which were, in fact, unchanged from 1703 until 1798 (18, p. 211), converts the figures in effect into an index of quantity.

There are two main sources for employment figures in early years. The more important is the Census of Population, whose industrial classification yields, from 1851, the numbers of males and females "engaged in the cotton industry in Great Britain." There were changes in classification from time to time, notably in the early years and in 1921, which affect the comparability of the figures. The Census of Population figures have a somewhat wider coverage than the other series available, which is contained in the reports of the Factory Inspectors and relates to "Persons Employed in Cotton Factories in the United Kingdom." In neither of these series is any further breakdown available, in particular into spinning and weaving. The Factory Inspectors' returns go back to a much earlier date (1839) than the Census of Population.

There is very little information on machinery in the industry in the early years. A few figures can be picked up from some of the early historical books about the industry, but it is not until 1885 that any comprehensive and continuous figures appear. From that year, Worrall's *Directory* (31) compiled totals of spindles and looms installed in Lancashire, and the series is maintained up to the present day. The figures are not, of course, comparable with those obtained from other sources in more recent years (for example, they relate only to the Lancashire area), but they are internally consistent and invaluable in showing the trend of equipment over the period they cover.

Pre-war Statistics

The cotton industry even to-day is essentially an exporting industry, and it cannot be too highly emphasized that one of the best indices of its economic condition in past years is contained in the official figures of cotton goods exported from the United Kingdom. This is not the place to go into any great detail about the contents and scope of these well-known returns, which have been described in an earlier article in this series, but it is necessary to note that they must rank first among the sources of cotton industry statistics. The annual volumes, particularly the volume which gives exports classified by commodity and sub-classified by country of destination, give the greatest amount of detail, and the monthly accounts are useful currently for up-to-date information and for figures at more frequent intervals if such things as seasonal variations require to be studied.

In the Trade Accounts, cotton piece goods were recorded in terms of linear yards until 1919,

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and from 1921 in linear yards, square yards and weight. (Square yards only were used in 1920.) There have been very few changes in the range of goods included under the heading "Cotton Piece Goods"; the most important were in 1939, when knitted piece goods were excluded for the first time, and in 1913, when printed flags, handkerchiefs and shawls not in the piece were excluded. The inclusion of the former in earlier years affects their comparability not only with the later figures but also with the production figures in the Census of Production, since knitted goods are not a product of the cotton-weaving industry.

TABLE 1

Exports of Cotton Piece Goods from the United Kingdom

Yearly average	*Million linear yards*	*Yearly average*	*Million linear yards*	*Million square yards*
1820–24	1,310	1885–89	4,837	..
1825–29	347	1890–94	4,975	..
1830–34	476	1895–99	5,140	..
1835–39	630	1900–04	5,295	..
1840–44	848	1905–09	6,002	..
1845–49	1,107	1910–14	6,479	..
1850–54	1,543	1915–19	4,441	..
1855–59	2,168	1920–24	4,066 (a)	4,021
1860–64	2,097	1925–29	4,096	3,985
1865–69	2,654	1930–34	2,152	2,069
1870–74	3,463	1935–39	1,788	1,713
1875–79	3,683	1640–44	657	611
1880–84	4,516	1945–48	551	563

NOTES:
Includes flags, handkerchiefs and shawls not in the piece up to 1912.
Includes knitted piece goods up to 1938.
(*a*) Average of 1921–24.

For production figures before 1939 the most important source is the Census of Production, with which the reports in 1933, 1934 and 1937 of the Import Duties Advisory Committee are assumed to be included. The Census of Production has already been covered generally in an earlier article in this series, but the following notes are added, with particular reference to the reports on the cotton industry.

The exclusion from Census of Production figures of firms with less than 10 employees is not of great importance for the cotton industry. It has little or no effect on the spinning section, but does make a small difference to the weaving figures (in 1949 about 0·8 per cent. of cloth was produced by firms employing less than 10 operatives). The exclusion also will have very little effect on figures for the finishing section of the industry.

TABLE 2

Production of Cotton and Waste Yarn

Million lb.

	1907	1912	1924	1930	1933	1934	1935	1937
Total	*1,800*	*1,983*	*1,395*	*1,047*	*1,180*	*1,204*	*1,228*	*1,358*
Up to 20's: Waste					465	484	109	124
Cotton	..	..	1,022	822			404	458
Over 20's up to 26's					484	500	498	182
,, 26's ,, 40's								372
,, 40's ,, 56's	..	..	314	185	113	101	102	109
,, 56's ,, 80's					78	77	75	72
,, 80's ,, 120's	..	..	56	37	37	37	37	37
,, 120's	..	..	4	3	3	4	3	4

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In the spinning section the most important figures are those of the total make of cotton yarn, which are compiled with the object of eliminating possible duplication where yarn is subsequently subjected to other processes in the establishment where it was spun. The details about production of yarn have been considerably expanded with successive censuses. In 1924 there were only four groups of counts, but this has now increased to eight, which give a very useful break-up of the total production. In recent years also the other details have been expanded; for example the returns now show the production of yarns from synthetic fibres, and the consumption of a number of important raw materials besides raw cotton. The Census of Production treats rayon as part of the silk industry rather than cotton, and therefore to cover the cotton industry as we have defined it the silk and rayon schedules must be considered as well as cotton. (This is an anachronism which might usefully be rectified; in the infancy of rayon its inclusion with silk was reasonable, but rayon is now overwhelmingly preponderant.) The inclusion of silk does not affect the figures of production of rayon fabrics, but does, of course, affect the comparability with other statistics of the figures of raw materials used, employment, etc. The details of production in the weaving section of the industry have also been expanded considerably in the later censuses, and the list of items in the schedules for 1948 is very comprehensive. The reports on the weaving section of the industry give, of course, particulars of cloth in the loom state and, for information on cloth as it is finally used, must be supplemented by the information given in the reports on textile finishing. These include the amount of cloth bleached, dyed but not printed whether bleached or not, and printed whether bleached or dyed or not, so that the difficulty of duplication where one cloth goes through two or more finishing processes is largely avoided. In addition to the production for sale and on commission of cotton cloth in the piece, the weaving reports give the production of a number of made-up articles such as sheets, blankets and towels. These goods are, in fact, made up into their finished form by the firm which weaves the cloth, and in order to obtain a figure of the total output of the weaving industry an estimate of the cloth content of these made-up articles must be included. It amounts to about 6 per cent. for 1937.

TABLE 3

Production of Cotton and Rayon Piece Goods

Million square yards

	1912	1924	1930	1933	1934	1935	1937
Cotton Piece Goods:							
Total	8,050*	6,026†	3,399†	3,504	3,457	3,384	3,806
Of grey yarn	7,331*	5,548†	3,061†	3,108	3,072	2,979	3,404
,, dyed yarn	719*	478†	291†	372	362	382	376
,, bleached yarn	..	..	18†	3	3	3	3
Pile fabrics	..	..	29	20	21	19	23
Rayon Piece Goods:							
Wholly of rayon	..	..	59·3	147·4	213·0	227·1‡	321·5‡
Containing staple fibre	..	..	..	..	..	12·9	72·9
Other§	..	..	..	..	..	214·2	248·6
Of rayon mixed with other materials	..	..	120·9	221·8	186·6	152·7‡	160·8‡
Containing staple fibre	..	..	..	..	..	8·0	15·5
Damasks, tapestries, brocades, etc.	..	..	..	..	..	40·2	56·7
Other§	..	..	..	..	..	104·5	88·6

* Million linear yards.

† Including some towels and bed coverings. Total production excluding these items in 1930 was 3,320 million square yards.

‡ Excluding knitted rayon piece goods produced by the rayon industry, which are included in figures for previous years. Production of knitted goods (wholly of rayon for the most part) by the rayon industry in 1935 was about 45 million square yards.

§ "Other" may include some goods containing staple fibre.

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The usefulness of the Census of Production reports is greatly increased by the fact that they record values as well as quantities. No other production statistics, in the cotton industry at least, share this advantage. They are also valuable in providing, on schedules for industries other than cotton, some useful information on the consumption of cotton products. The number of industries for which these details have been shown separately in the past has been rather limited, but is extended considerably in the 1948 enquiry.

From 1920 the principal source of statistics of labour in the cotton industry is the figures collected by the Ministry of Labour. The scope and the various changes that have been made from time to time in these figures have been adequately set out in a booklet issued by the Ministry (6), and it is not proposed to repeat any of the information given there except in so far as the cotton industry in particular is affected. The total number of employees in the industry was until 1948 obtained from the count in July each year of the number of insurance books exchanged, and the figures emerging from this count are analysed into industries, sex, juvenile and adult workers. For intervening months the number of employees was estimated, the figures being revised when the figures from the next year's count were available. From 1948 a quarter of the books have been exchanged every three months, so that although there should no longer be a definite figure for one date of the year, the monthly estimates will be more accurate. It is understood that this method of compiling the figures is not yet fully in operation. The industry classifications covering the cotton industry are spinning (including waste spinning and doubling), cotton weaving, silk and rayon weaving, and textile finishing. These classifications correspond with the Census of Production classifications of industry. The Ministry also publishes every month the number of unemployed analysed by industries and sex, but not in this case by age groups, which were given only for the country as a whole.

The Ministry now also makes an estimate of the total manpower in each industry group, obtained by adding to their regular figures an estimate of the number of uninsured workers. For the cotton industry the difference is small. Mention must also be made of a sample enquiry (based on about 2 per cent. of books exchanged) which has been made since the war; this sample yields figures of the age distribution of operatives and of the rate of turn-over of labour. The figures are published in total only, but it is understood that although it is not published, an analysis by industries is also made.

The Ministry of Labour's figures are clearly the best source where movements in labour over a period of time are of interest, but if it is required to compare labour with production it is usually necessary to rely on the other sources, i.e. Census of Production figures before the war and the Cotton Board's figures in post-war years. The employment figures published by the Ministry of Labour and in the Census of Production are not identical, although the employment figures in the Census reports were compiled by the Ministry of Labour, but there are substantial differences between the Ministry of Labour's figures and those collected and published by the Cotton Board. These arise through differences of classification; the figures are collected independently, and the boundaries of the different sections of the cotton industry are necessarily rather different in the two sets of figures. For example, the Ministry of Labour includes waste spinning and doubling with cotton spinning; it also includes a certain number of operatives employed by firms who perform only processes ancillary to spinning, such as winding, and also the operatives employed on some of these processes in the spinning mills themselves. In particular, the Ministry of Labour figures include some operatives engaged in the production of sewing thread. The Ministry of Labour also follows the Census of Production in distinguishing between cotton and rayon weaving, and includes silk weaving in its rayon weaving-classification. The whole of the textile finishing industry is treated as one unit and, therefore, provides a very poor guide to the state of employment in the cotton-finishing industry.

The Census of Production statistics of production of cotton yarn can be augmented from a number of other sources. Of these one of the most useful is some figures of raw cotton consumption published before the war by the International Federation of Master Cotton Spinners' and Manufacturers' Association. Statistics of cotton consumption can be used to give a good estimate of yarn production, since the percentage of waste in the spinning process is reasonably constant over the industry as a whole. The percentage can be obtained from Census of Production figures, and for the production of cotton yarn can be taken at 12 per cent. Allowance must be made, however, for the subsequent use of part of the waste in the production of waste yarn,

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which reduces the total percentage loss considerably. The International Federation figures, which related to all the important cotton manufacturing countries of the world, were published every six months (22), and gave the consumption of all important growths of cotton in terms of bales. The periods used by the International Federation were related to cotton crop years and, therefore, ended in July and January; these, however, are sufficiently near the calendar year terminations for most practical purposes. They are available from 1905 onwards. They form an invaluable link in the series of cotton yarn production between the Census years.

Another source of yarn production figures which was available monthly is sometimes useful when short period fluctuations in production have to be studied. This is a series of estimates made before the war by the Joint Committee of Cotton Trade Organisations (19), which was based on sample figures of production compiled weekly by two of the spinning associations, and which, together with the figures for a big spinning combine, covered about 80 per cent. of the spinning industry. These figures, of course, give only the total production, with no details of the division between types. The figures are available from 1931. A further source is also worth noting, because it gives some further details for one or two years not covered by the Census of Production figures. These are contained in the Annual Reports of the Spindles Board (8), a body set up in 1936 to buy up and scrap surplus machinery in the spinning industry, which, to assist in the execution of its duties, obtained some fairly detailed statistics of yarn production and spindle activity at six-monthly intervals. Unfortunately, the periods to which the figures relate, ending during March and September, are very difficult to relate to figures obtained from other sources.

The different sources enable fairly complete figures of yarn production over a long period to be obtained. For cloth production the position is not so good, and there are in fact virtually none available other than those given in the Census of Production. Efforts have been made from time to time to estimate production in the inter-censal years by calculating the amount of yarn available for home consumption, and assuming that the relation between this and cloth produced is the same as in the Census years. These attempts have usually failed, mainly because no information is available about stocks of materials at various stages of manufacture, especially stocks of yarn, and these do, in fact, change substantially in times of rapidly changing economic conditions. Figures with some pretension to reliability have, however, been estimated for the years 1938 and 1939, and were published in a report issued by the Cotton Board (16).

Some clue to the growing importance of rayon in the cotton industry in pre-war years can be obtained from the figures of rayon yarn and rayon waste subjected to excise duty which were published at quarterly intervals by the Customs and Excise. The proportion going into the cotton industry can be estimated from the figures for the Census of Production years. The excise duty was repealed in 1948, and since then the Board of Trade have published figures of actual production, with the pre-war excise statistics, adjusted to a comparable basis, shown for comparison.

Statistics of consumption and stocks of raw cotton were fairly complete before the war. The most important source was the International Federation mentioned above (22), which gave particulars of mill consumption and mill stocks of all the main types of cotton every six months. Statistics of stocks at the ports, which together with mill stocks accounted for nearly all the raw cotton in the country, were published by the Liverpool Cotton Association (24). The Liverpool Cotton Association also published very detailed information on prices of cotton both in this country and abroad.

The International Federation also gave figures in their half-yearly publication of the number of spindles installed, and in course of erection. Separate figures were given for mule and ring spindles. These figures extend back to 1905, and are the best for the period which they cover. Loom statistics are less complete, but for three pre-war years (1930, 1933 and 1936) the International Federation also took a loom census covering all countries (23). For the United Kingdom these figures are very complete and reliable; a useful amount of detail is given (especially for 1936), including the distinction between automatic and non-automatic looms, and the number running on rayon. The number of hours worked per week is also given.

The Present Position

Before the war the student investigating the economics of the cotton industry had to dig for his material. There is now almost a danger that he may be overwhelmed by the quantity of statistics available.

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The Census of Production must still rank as one of the most important sources, because of the great detail which is required on the schedules. The Census is now taken every year, and the results for 1948 are expected some time during 1950. The work has, however, been so heavy that the information collected for 1949 has been drastically reduced. The scope of the Census as it affects the cotton industry has been extended by the addition of a few more details of production and by the inclusion of merchant converters as part of the producing section of the industry. The merchant converter is an important unit in the textile industry. He is in touch with the markets, both at home and abroad, and according to the requirements of his customers and his own estimate of the trend of demand and fashion, he buys grey cloth (i.e. direct from the loom) and has it finished on commission to his own specification. During a large part of the production process he supplies the necessary finance. Thus the finishing industry, in particular, works almost entirely on commission, and it is only from the merchant converter that statistics of sales, as distinct from production, of finished cloth can be obtained. Another valuable addition to the census consists of a considerable extension of the statistics of consumption of cotton yarn and piece goods in other industries. Final judgment on the value of the census in post-war years must be reserved until the results for 1948 are available.

Before passing on to a detailed description of the additional statistics of the cotton industry which are now available, it would be as well to mention that there is one exception to the general increase in their volume. The purchase of raw cotton is now in the hands of the Raw Cotton Commission, who are reluctant to publish much detail about raw cotton consumption and stocks because of the possibility that their activities in purchasing cotton abroad might be jeopardized if the supply position in this country were too well known abroad. A few general totals of stocks (in mills, and held in this country by the Raw Cotton Commission) and consumption of raw cotton are, however, published in the *Monthly Digest* (7). Consumption is subdivided into consumption in the cotton-spinning industry and consumption elsewhere, but no other breakdown is given. Statistics of stocks and consumption of cotton waste are collected by the Board of Trade, and also published in the *Monthly Digest*.

The most important source of statistics of the cotton industry since the war is the statistics collected by the Cotton Board. The Cotton Board was set up in 1940 to serve as a central representative council of the industry, and in particular to advise the Board of Trade on problems of war-time control. Under the Industrial Development Council Act of 1947 it was reconstituted as a Development Council, and took over, under the powers conferred on it by the Cotton Industry Development Council Order, the task of collecting statistics relating to the industry, which had been done during the war by the Board of Trade. These statistics are very comprehensive, and cover most aspects of the activity of the cotton industry; to a large extent they are a continuation of statistics collected during the war by the Board of Trade, but a number of modifications have been made mainly with a view to retaining information which will be of importance from a long-term point of view, and discarding when practicable information which was merely obtained for the performance of administrative duties during the war and in the years immediately following.

For the spinning section of the industry the information collected consists of the production of yarn, subdivided into a number of count groups (which correspond with the Census of Production subdivision); deliveries, and sales of cotton yarns; spinning machinery installed and operating and the number of hours worked; and the number of operatives both on the books and actually working, subdivided into male and female, juvenile and adult. These figures are collected weekly, and except for those relating to sales, are published in a number of places; a few weekly totals are published regularly in the Press, monthly averages in a little more detail are given in the *Board of Trade Journal*, and the Cotton Board itself publishes quarterly figures showing all the most important figures in its *Trade Letter* (Statistical Supplement) (12).

Similar figures are collected for the waste spinning industry and are published in the same places. For the doubling section of the industry there are similar figures of production (subdivided into count groups and including the production of yarns doubled from continuous filament rayon), machine activity and employment.

For the weaving section of the industry the Cotton Board statistics are collected monthly. They cover production of cloth (showing a few of the most important types and separating rayon and mixtures from cotton), loom activity, hours worked and employment. In addition, there are figures of the yarn consumed by the weaving industry, showing cotton, cotton yarns, waste yarns,

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continuous filament rayon, spun rayon and nylon separately. Statistics of weavers' order books are also collected but have not so far been published.

Similar statistics covering production and employment are collected from the finishing section of the industry. This section is subdivided into bleaching, printing, dyeing, yarn processing and one or two smaller sections, and for the printing section of the industry statistics of machine activity are also available. The Cotton Board has not yet published regular figures of production in the finishing industry (see, however, Cotton Board Trade Letter, No. 66, February, 1950), but has given them in the form of a percentage comparison with pre-war years.

Not all the statistical information collected by the Cotton Board is published. Apart from those noted above, of order books in each section and production in finishing, a certain amount of statistical information is withheld for reasons of policy. More details are, however, available to the student than it has so far been possible to publish, and would be available on request.

In addition to the regular short period statistics, the Cotton Board has made a number of special surveys of machinery in the cotton industry. The first one, made jointly by the Cotton Board and the Cotton Control, related to the spinning industry and was published in 1947. This gives very complete details of the machinery installed, and some indication of the extent to which it has been kept up-to-date. The second of these surveys gives similar details for the waste-spinning section of the industry, and the third, published in 1949, gives similar particulars for the weaving section.

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Household Expenditure on Food in Holland

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I. *Plan and Statistical Material of the Investigation*

Introduction

The purpose of this paper is to investigate the manner in which a household's expenditure on food is affected by its total income and size, by the occupation of the chief money-earner, and by the type of region and particular neighbourhood in which the household is situated.

It is essential that such an investigation should be limited to one fairly homogeneous people. Otherwise differences in customs and habits of thrift and good living might be so large as to swamp these lesser variations. For this purpose Holland is a satisfactory unit, since from the racial, geographical and economic points of view it exhibits no heterogeneity which would disturb too violently the effects we wish to consider.

Influences on Food Consumption

The existence of more than one factor which may have an appreciable effect on the total food consumption of a household presents some difficulty. The relation between the consumption of food and any one of these factors will not be given by making a simple two-variable analysis on the appropriate variables, as the influence of the other factors must be taken into account. The easiest solution would be to group the data available in such a way that in each of the groups all explanatory variables save one should have the same, or approximately the same, value; but here this method will not succeed, as the number of groups would have to be so large that only a very small number of observations could be taken for each group.

However, another approach to the problem is possible, since in the present case the most important factors influencing food consumption—those in fact having an intrinsic economic importance, as opposed to those causing a more superficial variation—would appear to be the size of the household and the total disposable income of the household, and suitable numerical measures can be found for both these factors. Hence a multiple regression of food consumption on the two resulting variables can be made.

There are, however, still such differences in circumstances as the region in which people live, and the occupation class or classes to which those members of the household earning a money income belong. No numerical measure is available for such factors, so it was impossible to include them directly in a multiple regression analysis. Since their influence also was to be considered, the observed households were accordingly grouped so that these factors were more or less constant in any one group. The numbers of groups had to be relatively small, but they were made as homogeneous as possible. Hence any remaining variation in food consumption within one of the groups could be directly attributed to variations in size of household and total disposable income, plus an error variation due to different individual habits and tastes, while differences between groups could be attributed to the secondary factors.

Description of the Statistical Material

The source of the statistical material used in this study is a publication of the Netherlands Central Statistical Bureau on the budgets of 598 households.* This inquiry covered the period 1935–1936 (for some of the families June 29th, 1935, to June 26th, 1936, for the rest September 28th, 1935, to September 25th, 1936; but the variation of prices and general conditions during the three months at either end was negligible). Thus information on the budgets was provided for 52 consecutive weeks.

For the present investigation the households were grouped according to the economic and geographical districts in which they lived and the occupation classes to which the chief money-earners belonged. Table 1 gives the number of households in each of the groups so obtained.

* *Huishoudrekeningen van 598 Gezinnen*, 's Gravenhage, 1937 and 1938.

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No calculations were made for the groups including less than ten observations, and this is indicated in the table by putting the number in these groups in brackets. Owing to this restriction the total number of observed households was reduced to 526.

TABLE 1

Number of Families in Each Group

Occupation classes	*Districts*													*Total*
	Ia	Ib	Ic	IIa	IIb	IIc	IIIb	IIIc	IVa_1	IVa_2	IVa_3	IVb	IVc	
1	34	(1)	11	31	(4)	23	(8)	16	37	31	38	(1)	43	264 (14)
2	22	(2)	27	12	(5)	37	(7)	24	..	47	..	(—)	23	192 (14)
3	(—)	(8)	(4)	(—)	17	(1)	(9)	(2)	..	(—)	..	(—)	(—)	17 (24)
4	(—)	12	(7)	(1)	26	(1)	15	(6)	..	(—)	..	(5)	(—)	53 (20)
Total	56	12	38	43	43	60	15	40		153		—	66	526
„	(—)	(11)	(11)	(1)	(9)	(2)	(24)	(8)		(—)		(6)	(—)	(72)

Fuller reference as to the households included in each of the groups is given in Table 1 of the appendix, where they are referred to by their reference numbers in the Dutch publication. Table 2 of the appendix gives information as regards the division of the country into four main regions numbered I to IV, and also gives the names of towns and municipalities in which observations were made. A further grouping of the main regions into subdivisions *a*, *b* and *c* was made as follows:

Group (*a*).—Large municipalities, in so far as a sufficient number of households in these municipalities contributed to the inquiry; these consisted of Groningen in Region I, Enschede in Region II, and Eindhoven, Tilburg and Heerlen in Region IV.

Group (*b*).—Agricultural municipalities, i.e. those in which at least 40 per cent. of the population is engaged in agriculture.

Group (*c*).—Other municipalities.

From Table 2 of the appendix it will be seen that two main cities, Amsterdam and The Hague, did not contribute to the original survey. District IV*a* was split into three parts:

(i) Eindhoven (engaged mainly in the production of Philips products, such as radios, electric lamps, etc.),

(ii) Tilburg (engaged mainly in the textile industry), and

(iii) Heerlen (a mining town),

in order to see whether there were any significant differences in the results for these towns, attributable to the differences in their chief industries.

The classes of occupation of the chief money-earners were:

Class 1.—All manual labourers (except for farm labourers) and others on the same level.

Class 2.—Professional workers and all others on the same level.

Class 3.—Farm labourers.

Class 4.—Farmers.

As seen in Table 1 above, this division provided in all 20 different groups in which there were a sufficient number of households for further discussion to be possible. A household is here taken to mean any collection of two or more people living together, but not including boarders, servants or guests. The source from which the values of the three variables for each household were calculated was Table 1 (pp. 38–97) of Part I of the Dutch publication referred to above.

The first variable, food expenditure, was the total expenditure on foodstuffs at retail value, such as bread and cakes, beans, rice, flour, potatoes, vegetables, fruit, sugar, tea, coffee, cocoa, chocolate, jam and spices, fats and oils (including butter and margarine), meat, fish, milk, cheese and eggs, but not drinks bought in liquid form or expenditure in public houses, etc. For the measure of the total food expenditure for the year the figure in row "D, 1–16, totaal voeding" of the table referred to was taken, and from it subtracted the sum of rows "D6 dranken" and "D16 cafébezoek."

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(These figures had been adjusted by the Dutch Central Statistical Office to allow for temporary presence and absence. The following simple example will show how this is done. A household contained husband and wife only; in the scale to be shortly described, this equals 1 + 0·9 or 1·9 consumer units. Temporary presence consisted of:

1 servant (0·9 units) for 52 days = 1 unit for 46·8 days.
1 guest (1 unit) for 22 days = 1 unit for 22·0 days.
1 guest (0·6 units) for 2 days = 1 unit for 1·2 days.
Total = 1 unit for 70 days.

Temporary absence, counting a hot meal as 0·4 of a day's consumption and a bread meal as 0·3 of a day's consumption, consisted of—

Head of household (1 unit) 21 days = 1 unit for 21·0 days.
Head of household (1 unit) 3 hot meals = 1 unit for 1·2 days.
(these were obtained without any cost from relatives)
Total = 1 unit for 22·2 days.

Hence the excess of temporary presence over temporary absence was 1 unit for 47·8 days. The family consisting of 1·9 units represented $1·9 \times 364 = 691·6$ man days, and the total expenditure on food was fl. 646. As a consequence of the temporary presence of 1 consumer unit during 47·8 days, the actual expenditure on food was in fact for 691·6 + 47·8 days or 739·4 days. Hence every food item and total food expenditure had to be multiplied by $\frac{691·6}{739·4}$ or 0·9354, in order to give an estimate of what the expenditure would have been for the whole of the 364 days for the man and his wife alone. Then the costs of feeding the guests, etc., were listed in the accounts under "charity, presents" and those of feeding the servant under "domestic help"; the cost of feeding during the holiday was subtracted from the total holiday expenditure, and the estimated cost of free meals received from relatives was added to the total income.)

The second variable, the income of the household, not only included the actual money incomes (whether from economic activity or not) of all its members, but also their incomes in kind—wages and relief, presents, profits from the possession of a house or from the household's own production, and the profit from boarders. No correction for saving or dissaving was made, but for the numerical measure of total disposable income, the figure in row "A Inkomen" was corrected by that in row "D 37 Belastingen," (i.e. taxes) of Table 1 of the Dutch publication.

The third variable, the size of the household, was measured by the number of consumer units it contained. The scale used both here and in the Dutch publication is the one based on the 1917 inquiry into household budgets, and drawn up by the statisticians of the Dutch Labour Inspection. The scale is as follows:

Child of	0 years	= 0·15	consumer units.
,,	1 ,,	= 0·20	,, ,,
,,	2 ,,	= 0·30	,, ,,
,,	3 ,,	= 0·35	,, ,,
,,	4 ,,	= 0·40	,, ,,
,,	5 ,,	= 0·45	,, ,,
,,	6 ,,	= 0·50	,, ,,
,,	7 ,,	= 0·55	,, ,,
,,	8 ,,	= 0·60	,, ,,
,,	9 ,,	= 0·65	,, ,,
,,	10 ,,	= 0·70	,, ,,
,,	11 ,,	= 0·75	,, ,,
,,	12 ,,	= 0·80	,, ,,
,,	13 ,,	= 0·85	,, ,,
,,	14 ,,	= 0·90	,, ,,
Females of	15 and over	= 0·90	,, ,,
Males of	15 ,,	= 1·00	,, ,,

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This scale is not appreciably different from that proposed by the League of Nations, and will be used here instead of the latter since it was constructed solely with reference to Dutch families.

In evaluating the total number of consumer units of each household, the Dutch Central Statistical Office took into account changes in the composition of the household during the period of observation, e.g. due to birth, marriage, death, change of age of children, etc. Thus, a child born on September 21st, 1932, was counted as two years old for the first twelve weeks of the enquiry (from June 29th, 1935), and as 3 years old for the remaining 40 weeks. Hence it was taken as equivalent to

$$\frac{12 \times 0{\cdot}30 + 40 \times 0{\cdot}35}{52} = 0{\cdot}338 \text{ consumer units.}$$

In order to make our three variables of about the same order of magnitude, the actual measure used was 100 × total number of consumer units of each household.

II. *Statistical Analysis of the Data*

Form of Regression Equation

The variables obtained by the above methods will be represented by—

y = total food expenditure,
x_1 = total disposable income,
x_2 = 100 × number of consumer units in family,

values of which have been obtained from each observed household.

Two forms of regression equation of y on x_1 and x_2 were considered; firstly the form,

$$y = \text{constant} + \alpha_1 x_1 + \alpha_2 x_2,$$

referred to as the linear approach, and secondly

$$\log y = \text{constant} + \beta_1 \log x_1 + \beta_2 \log x_2,$$

referred to as the logarithmic approach (this second form being of particular interest as it assumes constant elasticities of food consumption with respect to income and family size).

Analysis of Covariance with Two Independent Variables

For each form of regression equation, an analysis of covariance of the data was carried out.

In principle this is as follows*: it assumes that one regression equation is applicable for the whole population, i.e. that the dependence of y on x_1 and x_2 does not vary significantly from group to group, and hence that the secondary set of factors have no effect on the explanation of y. Apart from the regression effect, the variation of y is assumed to be normal with constant variance v. Then various estimates of v are made for the residual variation after the effect of the estimated regression has been removed; these are compared with one another to test whether the original hypothesis of homogeneity is tenable or not.

In the present case of 2 independent variables the procedure for the linear approach is as follows: Let y_{ij} be the jth value of y in the ith group, where j runs from 1 to n_i, and i runs from 1 to p. Let $\sum_{i=1}^{p} n_i = N$. Also let $\bar{y}_i$ be the mean of the y_{ij}'s in the ith group, and $\bar{y}$ be such that—

$$\sum_{1}^{p} n_i \bar{y}_i = N\bar{y}.$$

* For further discussion see an appendix by E. S. Pearson to a paper by Wilsdon (1934), and Kendall (1946). Also Brady (1935) deals with an example in biology.

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We proceed to calculate:

$$C_i = \sum_{j=1}^{n_i} (y_{ij} - \bar{y}_i)^2 \quad \text{for all } i$$

$$C = \sum_{i=1}^{p} C_i$$

$$C' = \sum_{i=1}^{p} n_i(\bar{y}_i - \bar{y})^2$$

$$C'' = \sum_{i=1}^{p} \sum_{j=1}^{n_i} (y_{ij} - \bar{y})^2 = C + C'.$$

and similarly for the sums of squares of x_1, x_2 and for sums of products. A table of the following form is obtained:

TABLE 2

Variation	*Degrees of freedom*	*Sums of squares*			*Sums of products*		
		x_1^2	x_2^2	y^2	x_1x_2	yx_1	yx_2
Within i^{th} group ($i = 1, 2 \ldots p$)	$n_i - 1$	A_i	B_i	C_i	P_i	Q_i	R_i
Within groups	$N - p$	A	B	C	P	Q	R
Between groups	$p - 1$	A'	B'	C'	P'	Q'	R'
Total	$N - 1$	A''	B''	C''	P''	Q''	R''

Then the regression coefficients a_1 and a_2 which estimate α_1 and α_2 are given by—

$$a_1 = \frac{BQ - PR}{AB - P^2} \quad \text{and} \quad a_2 = \frac{AR - PQ}{AB - P^2}$$

with the appropriate suffixes or primes inserted in the quantities on the right-hand side of these expressions, depending on which row in the above table is under consideration. These quantities are calculated for every row in turn, and can be entered in two further columns at the side of the above plan, giving a_{1i}, a_1, a_1' and a_1'' respectively, and similarly for a_2. A similar procedure is applied for the calculation of the regression coefficients of $Y = \log y$ on $X_1 = \log x_1$ and $X_2 = \log x_2$. The actual values obtained from our data are given in Table 3 (linear approach) and Table 4 (logarithmic approach).

Elimination of Regression

The required estimates of v are now given by sums of squares of the y's corrected for regression on x_1 and x_2, of the form $C - a_1 Q - a_2 R$ with the appropriate suffixes or primes again inserted. Two more constants beside the means have now been fitted, so the number of degrees of freedom for each separate corrected sum of squares is reduced by 2. The form shown in Table 5 can be obtained (again see the references given in Note 2):

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TABLE 3

Linear Approach

Group	Degrees of freedom	A	B	C	P	Q	R	a_1	a_2
Occ. Cl. 1:									
1 (Dist. I*a*)	33	2,658,058	790,791	763,748	749,731	1,051,714	674,020	·21193	·65141
2 („ I*c*)	10	949,438	174,779	142,138	144,215	195,801	140,187	·09649	·72246
3 („ II*a*)	30	3,199,630	593,929	519,741	622,505	915,855	410,998	·19044	·49240
4 („ II*c*)	22	4,713,948	158,238	474,521	384,686	994,983	238,860	·10964	1·24296
5 („ III*c*)	15	3,892,290	383,345	810,964	831,934	1,431,305	510,983	·15448	·99771
6 („ IVa_1)	36	8,790,681	1,689,316	1,764,525	2,212,213	3,051,424	1,587,477	·16502	·72362
7 („ IVa_2)	30	9,735,406	1,747,033	2,054,786	2,824,033	3,457,687	1,817,173	·10063	·87749
8 („ IVa_3)	37	5,124,967	769,435	1,091,733	1,162,873	1,921,459	749,004	·23444	·61913
9 („ IV*c*)	42	6,967,673	1,106,319	1,147,054	1,637,186	2,044,588	957,852	·13798	·66161
Occ. Cl. 2:									
10 (Dist. I*a*)	21	42,040,232	367,466	336,945	−542,541	1,450,764	270,208	·04485	·80156
11 („ I*c*)	26	75,250,352	254,046	855,218	800,524	5,115,655	337,384	·05572	1·15245
12 („ II*a*)	11	12,953,809	54,248	221,266	225,062	1,107,500	81,689	·06394	1·24057
13 („ II*c*)	36	94,302,304	406,360	1,150,632	1,009,099	6,018,008	534,999	·05109	1·18971
14 („ III*c*)	23	33,740,085	387,000	709,212	170,387	2,111,887	420,574	·05723	1·06156
15 („ IV*a*)	46	494,378,409	992,485	3,607,254	−404,032	26,523,844	1,231,683	·05468	1·26327
16 („ IV*c*)	22	61,368,729	399,531	1,319,214	283,249	5,385,494	490,229	·08236	1·16862
Occ. Cl. 3:									
17 (Dist. II*b*)	16	481,587	411,390	168,810	198,180	205,042	210,540	·26836	·38250
Occ. Cl. 4:									
18 (Dist. I*b*)	11	3,741,339	79,677	251,504	−15,957	282,033	109,003	·08129	1·38434
19 („ II*b*)	25	16,894,039	761,566	1,206,725	1,059,089	2,096,345	789,950	·06470	·94729
20 („ III*b*)	14	3,794,414	145,855	641,698	−315,959	−859,615	265,067	−·09177	1·61852
Within groups	506	884,977,389	11,672,809	19,237,688	13,036,476	64,501,773	11,827,879	·05893	·94747
Between groups	19	429,268,967	870,464	2,572,050	−9,307,245	22,923,706	179,163	·07533	1·01124
Total	525	1,314,246,356	12,543,273	21,809,738	3,729,231	87,425,479	12,007,042	·06386	·93826

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TABLE 4

Logarithmic Approach

Group	Degrees of freedom	A	B	C	P	Q	R	b_1	b_2
Occ. Cl. 1:									
1 (Dist. Ia)	33	·19252	·78776	·34248	·18599	·18236	·44170	·52840	·43666
2 („ Ic)	10	·11992	·28513	·10849	·05423	·06530	·14678	·34106	·44991
3 („ IIa)	30	·26128	·67757	·28247	·24093	·20645	·34328	·48052	·33577
4 („ IIc)	22	·37538	·29156	·33732	·14351	·25827	·26075	·42635	·68448
5 („ IIIc)	15	·33469	·55596	·46541	·27381	·32476	·46496	·47919	·60032
6 („ IVa_1)	36	·52538	1·39505	·71241	·48791	·46105	·91829	·39435	·52033
7 („ IVa_2)	30	·66642	1·66253	·80657	·66135	·57080	1·05593	·37378	·48645
8 („ IVa_3)	37	·41154	·87310	·44406	·29321	·34098	·47284	·58194	·34613
9 („ IVc)	42	·72668	1·27479	·61005	·56671	·50116	·74459	·35840	·42477
Occ. Cl. 2:									
10 (Dist. Ia)	21	·89592	·57574	·21545	—·03140	·21417	·27723	·25642	·49549
11 („ Ic)	26	·90629	·41799	·33010	·10826	·36320	·26692	·33483	·55188
12 („ IIa)	11	·41388	·13211	·15191	·09786	·19956	·10536	·35593	·53386
13 („ IIc)	36	1·51409	·79543	·55106	·22676	·52733	·53342	·25890	·59680
14 („ IIIc)	23	·68157	·55843	·32403	·08241	·23734	·34979	·27744	·58545
15 („ IVa)	46	3·38437	1·22595	1·06702	·02679	1·28577	·77382	·37498	·62301
16 („ IVc)	22	1·11140	·53314	·38932	—·06031	·35610	·29858	·35297	·59998
Occ. Cl. 3:									
17 (Dist. IIb)	16	·09330	·37472	·10736	·08373	·07266	·15687	·50429	·30595
Occ. Cl. 4:									
18 (Dist. Ib)	11	·30947	·09023	·13686	·01904	·07538	·08828	·18579	·93916
19 („ IIb)	25	·85261	·55519	·42863	·19922	·32524	·42066	·22314	·67761
20 („ IIIb)	14	·23110	·23642	·24425	—·10233	—·12919	·22076	—·18004	·85582
Within groups	506	14·00781	13·29879	8·05526	3·55766	6·43871	8·34082	·32226	·54098
Between groups	19	11·29455	1·07522	1·08053	—1·85168	2·31240	·16513	·32036	·70529
Total	525	25·30236	14·37401	9·13579	1·70598	8·75111	8·50595	·30483	·55515

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TABLE 5

Variation	*D.F.*	*Sums of squares*	*Mean squares*
Deviations from regressions within groups	$N - 3p$	$S_1 = \sum_i (C_i - a_{1i}Q_i - a_{2i}R_i)$	$v_1 = \frac{S_1}{N - 3p}$
Differences among regressions within groups	$2p - 2$	S_2	$v_2 = \frac{S_2}{2p - 2}$
Deviations from average regression	$N - p - 2$	$S_1 + S_2 = C - a_1Q - a_2R$	$v_a = \frac{S_1 + S_2}{N - p - 2}$
Deviations of means from regression of means	$p - 3$	$S_3 = C' - a_1'Q' - a_2'R'$	$v_m = \frac{S_3 + S_4}{p - 1}$
Differences between $a's$ and $a''s$	2	S_4	
Total deviation from regression	$N - 3$	$\sum_{k=1}^{4} S_k = C'' - a_1''Q'' - a_2''R''$	

S_1, $S_1 + S_2$, S_3 and $\sum_1^4 S_k$ or $S_1 + S_2 + S_3 + S_4$ can be calculated directly by the given formulae, and S_2 and S_4 are then found by subtraction. S_1, which is the sum of p individual corrected sums of squares, has therefore $\sum_{i=1}^{p} (n_i - 3)$ or $N - 3p$ degrees of freedom. Table 6 (linear approach) and Table 7 (logarithmic approach) give the actual values for the quantities in this plan under the two approaches. We will consider each approach separately.

TABLE 6

Analysis of Covariance—Linear Approach

Variation	*D.F.*	*Sum of squares*	*Mean squares*
Deviations from regression within groups	466	$S_1 = 3{,}154{,}091$	6,768·4
Differences among regressions	38	$S_2 = 1{,}076{,}039$	28,317
Deviations from average regression	504	$S_1 + S_2 = 4{,}230{,}130$	8,393·1
Deviations of means from regression of means	17	$S_3 = 664{,}096$	38,470
Difference of average and means regression	2	$S_4 = 66{,}836$	
Total deviation	523	$\Sigma S = 4{,}961{,}062$	9,485·8

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TABLE 7

Analysis of Covariance—Logarithmic Approach

Variation	*D.F.*	*Sum of squares*	*Mean squares*
Deviations from regressions within groups	466	$S_1 = 1{\cdot}16142$	0·00249
Differences among regressions	38	$S_2 = 0{\cdot}30674$	0·00807
Deviations from average regression	504	$S_1 + S_2 = 1{\cdot}46815$	0·00291
Deviations of means from regression of means	17	$S_3 = 0{\cdot}22325$	0·01297
Difference of average and means regressions	2	$S_4 = \cdot02317$	
Total deviation	523	$\Sigma S = 1{\cdot}71457$	0·00328

Significance Tests for the Linear Approach

(1) We first wish to test whether we are justified in assuming that one regression equation,

$$y - \bar{y} = a_1(x_1 - \bar{x}_1) + a_2(x_2 - \bar{x}_2)$$

can be applied to the whole data without significant signs of heterogeneity.

Now $\dfrac{S_2 + S_3 + S_4}{3p - 3}$ provides an estimate v_t of v, and the ratio of this to v_1 can be tested by Fisher's variance ratio test to see whether our hypothesis is reasonable.

Then $F = \dfrac{v_t}{v_1} = 4{\cdot}684$;

the degrees of freedom are, for the numerator, $n_1 = 3p - 3 = 57$, and for the denominator, $n_2 = N - 3p = 466$. This is very highly significant (F lying above the 0·1 per cent. point), and indicates that there is some very definite heterogeneity in our data. We proceed to make further tests to investigate the various possible causes of this.

(2) Secondly we test $F = \dfrac{v_2}{v_1} = 4{\cdot}184$.

$n_1 = 2p - 2 = 38$, $n_2 = 466$. This is again significant at above the 0·1 per cent. point, which indicates that there are very significant differences among the regressions within groups. Hence $S_1 + S_2$ cannot be used as an estimate of error, and the coefficients a_1, a_2 which represent the average regression within groups have no meaning. Similarly v_3 and v_4 are found to be very significantly greater than v_1. Thus there is evidence of marked heterogeneity between the 20 groups.

Significance Tests in the Logarithmic Approach

(1) $F = \dfrac{S_2 + S_3 + S_4}{3p - 3} \Big/ v_1 = 3{\cdot}8931$,

with $n_1 = 57$, $n_2 = 466$; this again is very highly significant, lying above the 0·1 per cent. point, and so again one equation will not cover the whole data.

(2) $F = \dfrac{v_2}{v_1} = 3{\cdot}2388$, with $n_1 = 38$, $n_2 = 466$, and this too lies above the 0·1 per cent. point,

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so again regression equations within groups differ significantly from each other, and the average regression becomes meaningless.

Also $\frac{v_3}{v_1}$ and $\frac{v_4}{v_1}$ give values of F significant at the 0·1 per cent. point, so with the logarithmic approach as well there exists marked heterogeneity in our data.

Discussion of the Results

All the preceding tests seem to show that we can almost certainly reject the hypothesis that the differences between the regression coefficients of the various groups are due only to sampling fluctuations. This means, in fact, that differences in circumstances between households do, indeed, have an effect on the manner in which food expenditure depends on the disposable income and the size of the household. Unfortunately, our analysis can tell us nothing further unless we can determine where the heterogeneity of the regression coefficients lies.

Inspection of our regression coefficients a_{1i} and a_{2i}, b_{1i} and b_{2i}, for each of the twenty groups (see Tables 3 and 4) leads us at once to the conclusion that these groups fall into two distinct sets. The first, which we will call Set A, consists of all groups falling under Occupation Classes 1 and 3; the second, Set B, consists of all groups falling under Occupation Classes 2 and 4. The regression coefficients have the following ranges of values for the two sets; for the linear approach

a_1 (set A) lies between	0·096	and	0·27.	
a_1 (,, B) ,,	0·044	,,	0·082	(with one negative value).
a_2 (,, A) ,,	0·38	,,	1·24	(all but one value below 1).
a_2 (,, B) ,,	0·80	,,	1·62 (,,	two values above 1).

For the logarithmic approach:

b_1 (set A) lies between	0·34	and	0·58	(all but one value above 0·35).
b_1 (,, B) ,,	0·18	,,	0·37 (,,	one value below 0·35).
b_2 (,, A) ,,	0·30	,,	0·68 (,,	two values below 0·53).
b_2 (,, B) ,,	0·49	,,	0·93 (,,	one value above 0·53).

The separation into two sets is thus very marked, and is slightly more complete under the linear approach than under the logarithmic approach. It also agrees with the dictates of common sense. Occupation Classes 1 and 3 include all manual labourers and other workers on the same level, i.e. roughly the lower income groups, while Occupation Classes 2 and 4 include farmers, and all professional workers and others on the same level, i.e. roughly the middle income groups. Now it is quite likely that the food expenditure is less affected by disposable income, and more by size of household, when the income is large than when it is small. Hence it can reasonably be supposed that much of the heterogeneity among the regressions within groups is due to this broad division into two sets.

Further Analysis

Having reached the above conclusions, we would now like to proceed to make a full analysis of covariance using the 4 × 4 classification of Regions I to IV and Occupation Classes 1 to 4 which could be obtained from Table 1. But as we can see from this table, we have been forced to reject some groups of families for which there was not a sufficient number of observations. Because of this, not all of the cells of the 4 × 4 classification would be adequately represented, and in addition there is the further difficulty of unequal numbers of observations occurring in each cell. Hence further analysis on these lines would be impracticable.

Instead, therefore, further analyses of covariance were carried out, on identical lines with the previous ones, on Set A and Set B separately. The required sums of squares and products of the variables for individual groups have already been given in Tables 3 and 4. Tables 8 and 9 give the further values required for total variation within groups, variation between groups and for the total variation now that the sets are considered separately. Finally, four more tables following

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TABLE 8

Linear Approach

Variation	*D.F.*	*A*	*B*	*C*	*P*	*Q*	*R*	a_1	a_2
Set A:									
Within groups	271	46,513,680	7,824,575	8,938,020	10,767,554	15,046,816	7,297,093	·157910	·715284
Between groups	9	18,061,099	308,393	608,847	−27,790	1,400,075	265,079	·078852	·866655
Total	280	64,574,779	8,132,968	9,546,867	10,739,764	16,446,891	7,562,172	·128211	·760512
Set B:									
Within groups	235	838,463,710	3,848,234	10,299,668	2,268,922	49,454,957	4,530,786	·055886	1·144442
Between groups	9	146,406,154	349,369	1,066,352	−1,812,334	6,178,680	352,923	·058461	1·313437
Total	244	984,869,864	4,197,603	11,366,020	456,588	55,633,637	4,883,709	·055935	1·157366

TABLE 9

Logarithmic Approach

Variation	*D.F.*	*A*	*B*	*C*	*P*	*Q*	*R*	b_1	b_2
Set A:									
Within groups	271	3·707103	8·178120	4·216625	2·991379	2·983807	5·006006	0·441161	0·450755
Between groups	9	0·941000	0·366025	0·307811	−0·063765	0·283332	0·207338	0·343537	0·626306
Total	280	4·648103	8·544145	4·524436	2·927614	3·267139	5·213344	0·406261	0·470962
Set B:									
Within groups	235	10·300705	5·120667	3·838640	0·566280	3·454904	3·334818	0·301432	0·617912
Between groups	9	2·664300	0·512960	0·365713	−0·586710	0·269200	0·237159	0·271159	0·772478
Total	244	12·965005	5·633627	4·204353	−0·020430	3·724104	3·571977	0·288243	0·635091

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the plan of Table 5 were obtained, for the linear approach, set A and set B, and for the logarithmic approach for the two sets, respectively (Tables 10, 11, 12 and 13).

TABLE 10
Linear Approach—Set A

Variation	*Degrees of freedom*	*Sums of squares*	*Mean squares*
Within groups from individual regressions	251	1,081,859·8	4,310·2
Difference between individual regressions	18	260,629·9	14,479·4
Within groups from average regression	269	1,342,489·7	4,990·1
Between groups from mean regression	7	268,715·8	38,287·6
Difference between average and mean regression	2	75,872·7	
Total	278	1,687,078·2	..

TABLE 11
Linear Approach—Set B

Variation	*Degrees of freedom*	*Sums of squares*	*Mean squares*
Within groups from individual regressions	215	2,072,231·0	9,638·3
Difference between individual regressions	18	278,384·0	15,465·8
Within groups from average regression	233	2,350,615·0	10,088·5
Between groups from mean regression	7	241,597·5	27,922·1
Difference between average and mean regression	2	9,701·5	
Total	242	2,601,914·0	..

TABLE 12
Logarithmic Approach—Set A

Variation	*Degrees of freedom*	*Sums of squares*	*Mean squares*
Within groups from individual regressions	251	0·5725481	0·002281
Difference between individual regressions	18	0·0712570	0·003959
Within groups from average regression	269	0·6438051	0·002393
Between groups from mean regression	7	0·0806189	0·01089
Difference between average and mean regression	2	0·0174130	
Total	278	0·7418370	..

TABLE 13
Logarithmic Approach—Set B

Variation	*Degrees of freedom*	*Sums of squares*	*Mean squares*
Within groups from individual regression	215	0·5888693	0·002739
Difference between individual regressions	18	0·1477269	0·008207
Within groups from average regression	233	0·7365962	0·003161
Between groups from mean regression	7	0·1095169	0·01398
Difference between average and mean regression	2	0·0162605	
Total	242	0·8623736	..

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Significance Tests for the Linear Approach with Two Sets

(1) Set A: By taking approximate values it can be seen at once that all of the estimates of residual variance:

$$\frac{S_2 + S_3 + S_4}{3p - 3}, \; v_2 \text{ and } v_m$$

are very significantly greater than the error estimate v_1, at the 1 per cent. point, and so again heterogeneity among groups is too great for further analysis.

(2) Set B: Firstly, $$\frac{S_2 + S_3 + S_4}{3p - 3} \Big/ v_1 = 2.035;$$

with $n_1 = 27$ and $n_2 = 215$, this variance ratio is significant at the 1 per cent. point, so again one regression equation will not cover the complete set,

$$\frac{v_2}{v_1} = 1.605, \text{ with } n_1 = 18 \text{ and } n_2 = 215,$$

and this is just below the 5 per cent. point. The regression coefficients within groups can therefore be said not to differ significantly, though it appears probable there is actually some underlying difference between groups to make $\frac{v_2}{v_1}$ as high as it is. Nevertheless v_a can be used as the error estimate, without too much danger. Then:

$$\frac{v_m}{v_a} = 2{\cdot}769, \text{ with } n_1 = 9 \text{ and } n_2 = 233,$$

and this is substantially above the 1 per cent. point, indicating that most of the heterogeneity of the groups in Set B is due to effects of the regression of the means. For a household in the ith group, the most general regression equation that can be used (under the linear approach) is—

$$y - \bar{y}_i = a_1(x_1 - \bar{x}_{1i}) + a_2(x_2 - \bar{x}_{2i}),$$

where a_1, a_2 are the within groups estimates of the regression coefficients.

It remains to be seen whether the variation of group means can be attributed mainly to any particular mean. A table of means of y for each group, corrected for "within groups" regression on x_1 and x_2 was constructed (see Table 14), together with the corrected mean of the whole set. Only two of the corrected group means diverge seriously from this last value, those of Group 10 (i.e. Occupation Class 2, District I*a*) and Group 20 (i.e. Occupation Class 4, District III*b*).

To test the difference between two corrected means,

$$\bar{y}_p - a_1(\bar{x}_{1p} - \bar{x}_1) - a_2(\bar{x}_{2p} - \bar{x}_2)$$

and

$$\bar{y}_q - a_1(\bar{x}_{1q} - \bar{x}_1) - a_2(\bar{x}_{2q} - \bar{x}_2),$$

it can be shown* that the estimated variance of their difference is—

$$S^2\left\{\frac{1}{n_p} + \frac{1}{n_q} + \frac{\lambda^2 B - 2\lambda\mu P + \mu^2 A}{AB - P^2}\right\}$$

* See Wishart (1936).

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TABLE 14

Corrected Means, Linear Approach, Set B

Group	Number in group	$\bar{y}$	$\bar{x}_1$	$\bar{x}_2$	$\bar{y}$ corrected for regression	$\frac{1}{n}$
Occ. Cl. 2:						
10 (Dist. I*a*)	22	559·27	2,497·00	332·41	600·62	0·04545
11 (,, I*c*)	27	658·66	3,377·29	320·70	664·21	0·03704
12 (,, II*a*)	12	576·17	2,381·33	290·83	671·57	0·08333
13 (,, II*c*)	37	629·35	3,128·38	303·00	669·07	0·02703
14 (,, III*a*)	24	637·50	2,712·33	323·54	676·97	0·04167
15 (,, IV*a*)	47	777·15	4,146·62	371·19	681·93	0·02128
16 (,, IV*c*)	23	681·17	2,952·30	360·96	664·40	0·04348
Occ. Cl. 4:						
18 (Dist. I*b*)	12	677·75	1,803·58	400·08	680·40	0·08333
19 (,, II*b*)	26	672·23	1,768·54	418·00	656·34	0·03846
20 (,, III*b*)	15	738·80	1,755·30	368·60	780·18	0·06778
Total	245	671·32	2,907·31	351·44	671·32	0·00408

$a_1 = 0{\cdot}05589$.
$a_2 = 1{\cdot}14444$.
Corrected $\bar{y} = \bar{y}_i - a_1(\bar{x}_{1i} - \bar{x}_1) - a_2(\bar{x}_{2i} - \bar{x}_2)$.

where n_p and n_q are the numbers of observations on which the respective means are based, $\lambda = \bar{x}_{1p} - \bar{x}_{1q}$ and $\mu = \bar{x}_{2p} - \bar{x}_{2q}$, while S^2, A, B and P are estimated by the values in the "within groups" row (from Table 8). Then a t-test can be applied giving a value of t based on the same number of degrees of freedom as S^2.

Then $t_{(233)} = 3{\cdot}16$ for Group 10, with a probability of about 0·003, which is small enough to be regarded as significant even though we have deliberately selected the smallest value of 10 to test.

For Group 20, $t_{(233)} = 4{\cdot}44$, with a probability of 0·001, and this can again be regarded as highly significant in spite of selection.

Thus it appears that the main cause of a significant v_m/v_a ratio is due to the deviation of the means of these two groups from the regression plane. The corrected mean food expenditure of professional workers in Groningen seems to be significantly lower than the average, while that for farmers in District III*b* seems significantly higher.

Significance Tests for the Logarithmic Approach with Two Sets

(1) Set A:
$$\frac{S_2 + S_3 + S_4}{3p - 3} \Big/ v_1 = 2{\cdot}749;$$

with $n_1 = 27$ and $n_2 = 251$, this is above the 0·1 per cent. point and again there is no complete homogeneity.

$$\frac{v_2}{v_1} = 1{\cdot}735, \text{ with } n_1 = 18 \text{ and } n_2 = 251;$$

this is just above the 5 per cent. point, and we are in much the same position as with Set B in the linear approach. The evidence is of some slight underlying heterogeneity among regression coefficients within groups, but again we shall assume that this can be neglected, and will take v_a as our best estimate of error.

Then
$$\frac{v_m}{v_a} = 4{\cdot}421, \text{ with } n_1 = 9 \text{ and } n_2 = 269,$$

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and this is very highly significant (much above the 0·01 per cent. point), indicating as before that the regression of the means is causing most of the observed heterogeneity.

The means of Y for each group, and for the complete set, corrected for regression on X_1 and X_2, are given in Table 15, using the "within groups" regression coefficients. There is considerable spread in the deviations of the corrected group means from that for the set, accounting for the large value of v_m/v_a.

TABLE 15

Corrected Means, Logarithmic Approach, Set A

Group	Number in group	$\bar{Y}_i$	$\bar{X}_{1i}$	$\bar{X}_{2i}$	$\bar{Y}_i$ corrected for regression	$\frac{1}{n}$
Occ. Cl. 1:						
1 (Dist. I*a*)	34	2·7496	3·1825	2·5745	2·7268	0·02941
2 (,, I*c*)	11	2·6657	3·0944	2·4692	2·7293	0·09091
3 (,, II*a*)	31	2·7468	3·1724	2·5455	2·7406	0·03226
4 (,, II*c*)	23	2·6962	3·1455	2·4913	2·7273	0·04348
5 (,, III*c*)	16	2·7179	3·1692	2·5140	2·7283	0·06250
6 (,, IVa_1)	37	2·7890	3·2206	2·5861	2·7441	0·02703
7 (,, IVa_2)	31	2·7670	3·1617	2·5256	2·7761	0·03226
8 (,, IVa_3)	38	2·7787	3·1751	2·5492	2·7706	0·02632
9 (,, IV*c*)	43	2·7661	3·1100	2·5837	2·7712	0·02326
Occ. Cl. 3:						
17 (Dist. II*b*)	17	2·7053	2·9864	2·6063	2·7547	0·05882
Total	281	2·7508	3·1529	2·5528	2·7508	0·00356

$b_1 = 0{\cdot}44116.$
$b_2 = 0{\cdot}45076.$

Corrected $\bar{Y}_i = \bar{Y}_i - b_1(\bar{X}_{1i} - \bar{X}_1) - b_2(\bar{X}_{2i} - \bar{X}_2)$.

In particular, the lower income households from districts I*a*, I*c*, II*c* and III*c* seem to have rather low corrected mean food expenditures, those from districts IVa_2, IVa_3 and IV*c* rather high ones. For the three cities of IV*a*, Eindhoven (IVa_1) has a corrected mean about at the average, Tilburg and Heerlen noticeably higher ones. Applying the test for the differences in corrected means, we find:

(i) for Eindhoven and Tilburg, $t_{(269)} = 2{\cdot}68$, significant at the 1 per cent. level;
(ii) for Eindhoven and Heerlen, $t_{(269)} = 2{\cdot}35$, significant at the 2 per cent. level;
(iii) for Tilburg and Heerlen t is not at all significant.

Generally, it appears that among groups in Set A, differences due to regions and districts lived in have quite a considerable effect on the food expenditure of households, given income and family size, in contrast to Set B. It may be supposed that customs of the neighbourhood and traditions of self-respect or otherwise have greater influence as regards households at lower income levels than with those at middle income levels.

(2) Set B: Regressions within groups here differ very significantly, so it would appear that the linear approach is more satisfactory if it is desired to find an equation with constant regression coefficients over the whole group.

III. *Conclusions*

Range of Incomes

Before any definite conclusions can be deduced from the preceding analysis, it is first necessary to indicate the actual ranges of income for the twenty groups considered. These are given below in Table 16.

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TABLE 16

Group	*Households in group*	*Mean annual income (guilders)*	*Range of annual income (guilders)*
Occ. Cl. 1:			
(Dist. 1*a*)	34	1,546	1,120 to 2,235
(,, I*c*)	11	1,278	790 ,, 1,709
(,, II*a*)	31	1,521	986 ,, 2,375
(,, II*c*)	23	1,468	854 ,, 2,536
(,, III*a*)	16	1,557	881 ,, 2,364
(,, IVa_1)	37	1,726	1,034 ,, 3,117
(,, IVa_2)	31	1,540	849 ,, 2,828
(,, IVa_3)	38	1,539	880 ,, 2,738
(,, IV*c*)	43	1,347	774 ,, 2,295
Occ. Cl. 2:			
(Dist. 1*a*)	22	2,497	1,005 ,, 5,977
(,, I*c*)	16	3,377	1,622 ,, 3,410
(,, II*a*)	12	2,381	907 ,, 4,723
(,, II*c*)	37	3,128	1,147 ,, 8,662
(,, III*c*)	24	2,712	1,493 ,, 5,943
(,, IV*a*)	47	4,147	1,077 ,, 15,299
(,, IV*c*)	23	2,952	931 ,, 7,752
Occ. Cl. 3:			
(Dist. II*b*)	17	983	746 ,, 1,319
Occ. Cl. 4:			
(Dist. I*b*)	12	1,804	657 ,, 2,667
(,, II*b*)	26	1,769	903 ,, 3,485
(,, III*b*)	15	1,755	986 ,, 3,122

Hence it is seen that while our division into two sets corresponds very roughly with a division by income level, this correspondence is not by any means very close, and it must be considered what effect this might have on our analysis.

Division into Two Sets Considered

The most obvious anomaly in our division into two sets occurs with Occupation Class 4. There the mean annual income and the lower limit of the income range would seem to indicate that the three groups from this class should be included in Set A rather than Set B; but their presence in Set B did not cause any marked indications of heterogeneity among the regression coefficients for the linear approach. From Table 3 it is seen, however, that the estimates of a_1 and a_2 for these groups do tend to lie at the extremities of the ranges of values for the set; Group 20 in particular has, curiously, a negative value for a_1, presumably due to sampling effects, and a considerably larger a_2 than any other in the set.

Nevertheless, it is not unreasonable that groups under Occupation Class 4, i.e. farmers, should be included among the middle income groups for our analysis. Farmers undoubtedly pay little attention to the market prices of farm produce when they are considering how much of their own produce to consume themselves; they are likely to take as much of this as they reasonably need, with considerations for household size having more effect and considerations of income having less, than with other households on the same income level. In fact, their behaviour with regard to food consumption may be expected to be similar to that of the middle income groups of Set B, rather than to the lower income groups to which they appear to belong (but 1935–6 was a bad year for farmers, and their average annual income is probably considerably higher).

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Another reason can be advanced to explain why our division into two sets is more distinct than would appear from income considerations only, viz. that occupation class may affect food expenditure in yet other ways. Children in general gravitate towards the same kind of work as their fathers, and in the course of time a traditional standard of living is likely to become more or less rigidly adopted by any given occupation class. Thus manual labourers at the upper end of the income ranges for Set A will tend to be influenced by income and household size in much the same way as others in the same occupation class, while professional workers earning less than this will endeavour to keep up a higher standard of living even if they have to stint themselves elsewhere. Thus the difference in behaviour of households in the two sets is liable to be far more marked than might be supposed from the considerable overlap in income ranges.

Comparison of the Sets

We proceed to compare the average levels of food expenditure, income and household size in the different groups. Accordingly, the mean values of y, x_1 and x_2 for each individual group and for the two sets are given below in Table 17.

TABLE 17

Group	$\bar{y}$	$\bar{x}_1$	$\bar{x}_2$	*Group*	$\bar{y}$	$\bar{x}_1$	$\bar{x}_2$
1	578·1	1,545·9	400·3	10	559·3	2,497·0	332·4
2	477·6	1,278·0	316·5	11	658·7	3,377·3	320·7
3	572·1	1,520·9	372·9	12	576·2	2,381·3	290·8
4	516·3	1,468·2	320·5	13	629·4	3,128·4	303·0
5	564·4	1,557·4	358·3	14	637·5	2,712·3	323·5
6	648·0	1,726·4	428·7	15	777·2	4,146·6	371·2
7	630·7	1,540·2	391·6	16	681·2	2,952·3	361·0
8	620·6	1,539·4	377·3	18	677·8	1,803·6	400·1
9	605·7	1,346·7	414·1	19	672·2	1,768·5	418·0
17	516·1	983·2	428·9	20	738·8	1,755·3	368·6
Set A	588·8	1,484·7	388·6	Set B	642·8	2,907·7	348·5

On the average, then, households in Set B have a food expenditure of only 55 guilders more than those in Set A, have an income nearly twice as great, and a slightly smaller average household size (about 0·4 consumption units less). Since the difference in food consumption is relatively very small compared with the difference in income level, it may be deduced that the average income in Set A is more or less sufficient to buy as much food as the household requires, and that the slightly larger expenditure of Set B is almost entirely on better quality rather than greater quantity of food.

As a group professional workers from Eindhoven, Tilburg and Heerlen (i.e. Group 15) appear to be most comfortably placed, having the highest average food consumption and income, and with average household size only slightly above that for the set. At the other end of the scale are farm labourers (i.e. Group 17) with the very low average income of 983·2 guilders (over 500 guilders below the set average) and an average household size over 0·4 consumption units above the mean. Apart from farm labourers, the largest average households are those of manual labourers in Groningen (Group 1), in Eindhoven (Group 6) and in District IV*c* (Group 9); and of farmers (Groups 18 and 19, but not very markedly for Group 20). Agricultural districts as a whole have a mean household size of 4·1 consumption units as opposed to that of 3·6 for all other municipalities.

Definition of Elasticities

Let ε_1 be the elasticity of food expenditure with respect to disposable income, and ε_2 be the elasticity of food expenditure with respect to household size. Then assuming y to be a function of x_1 and x_2 only, we have:

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$$\varepsilon_1 = \frac{\partial y}{\partial x_1} \cdot \frac{x_1}{y}$$

and

$$\varepsilon_2 = \frac{\partial y}{\partial x_2} \cdot \frac{x_2}{y}.$$

If the linear form is assumed to be true, i.e.

$$y = \text{const.} + a_1 x_1 + a_2 x_2,$$

then

$$\varepsilon_1 = a_1 \frac{x_1}{y}$$

and

$$\varepsilon_2 = a_2 \frac{x_2}{y},$$

so that the elasticities vary from household to household, as y_1, x_1 and x_2 vary.

On the other hand, if the logarithmic form is assumed to be true, i.e.

$$y = \text{const.} \times x_1^{b1} x_2^{b2},$$

then

$$\varepsilon_1 = b_1$$

and

$$\varepsilon_2 = b_2,$$

giving constant elasticities.

Calculation of Elasticities

We shall proceed to estimate ε_1 and ε_2 for all groups under each approach. For Set A the individual group regressions must be used under the linear approach, and the elasticities for the ith group will be estimated by—

$$E_{1i} = a_{1i} \frac{\bar{x}_{1i}}{\bar{y}_i}, \quad E_{2i} = a_{2i} \frac{\bar{x}_{2i}}{\bar{y}_i},$$

while for the logarithmic approach the error estimates of β_2 and β_3 can be taken. These are given in Table 18.

TABLE 18

Group	*Linear approach*		*Logarithmic approach*	
	E_1	E_2	E_1	E_2
Occ. Cl. 1:				
1 (Dist. Ia) . .	0·567	0·451	0·441	0·450
2 (,, Ic) . .	0·258	0·479	0·441	0·450
3 (,, IIa) . .	0·506	0·321	0·441	0·450
4 (,, IIc) . .	0·312	0·772	0·441	0·450
5 (,, IIIc) . .	0·426	0·633	0·441	0·450
6 (,, IVa_1) . .	0·440	0·479	0·441	0·450
7 (,, IVa_2) . .	0·246	0·545	0·441	0·450
8 (,, IVa_3) . .	0·582	0·376	0·441	0·450
9 (,, IVc) . .	0·307	0·452	0·441	0·450
Occ. Cl. 3:				
17 (Dist. IIb) . .	0·511	0·318	0·441	0·450

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For Set B, on the other hand, the "within groups" values of a_1 and a_2 can be used, and the elasticities for the ith group under the linear approach are estimated by—

$$E_{1i} = a_1 \frac{\bar{x}_{1i}}{\bar{y}_i}, \; E_{2i} = a_2 \frac{\bar{x}_{2i}}{\bar{y}_i},$$

where $a_1 = 0 \cdot 056$ and $a_2 = 1 \cdot 144$.

For the logarithmic approach, on the other hand, the individual group regression coefficients b_{1i} and b_{2i} must be used. The elasticities are given in Table 19.

TABLE 19

Group	Linear approach E_1	Linear approach E_2	Logarithmic approach E_1	Logarithmic approach E_2
Occ. Cl. 2:				
10 (Dist. Ia)	0·250	0·680	0·256	0·495
11 (,, Ic)	0·290	0·557	0·335	0·552
12 (,, IIa)	0·231	0·577	0·356	0·534
13 (,, IIc)	0·278	0·551	0·259	0·597
14 (,, IIIc)	0·238	0·581	0·277	0·585
15 (,, IVa)	0·299	0·546	0·375	0·623
16 (,, IVc)	0·243	0·606	0·353	0·600
Occ. Cl. 4:				
18 (Dist. Ib)	0·149	0·675	0·186	0·939
19 (,, IIb)	0·147	0·711	0·223	0·678
20 (,, IIIb)	0·133	0·571	−0·180	0·856

From the earlier work it seems reasonable to put more faith in the logarithmic approach values for Set A, and the linear approach values for Set B; the regression coefficients involved in the calculation of these elasticities being based on a much greater number of households than for individual groups, the resulting values are less likely to be disturbed by sampling fluctuations.

Discussion of Income Elasticities

Comparison of the elasticities in Tables 18 and 19 shows that these are very much in line with our deductions concerning the group means. For Set B the values of E_1 under either approach are on the whole smaller than for Set A, and this contrast is more marked if we compare the more reliable logarithmic approach values for Set A with the linear approach values for Set B. It seems that just about the average Set A income level there is still some desire for greater food expenditure, but this is rapidly satisfied, and for households in Set B an increase in income is likely to result only in buying a higher quality and greater variety of food.

The food expenditure of farmers is considerably less responsive to movements in income, household size remaining fixed, than for any other group even in Set B. Since the mean food expenditures for all three groups of farmers' households were well above the Set B average, it can be assumed that not only do they consume from their own produce (or by means of barter, from their fellow-farmers') as much food as they require, but also that if their income does rise they are not persuaded into changing the pattern of their food consumption, even in quality, to as appreciable an extent as other Set B households. That is, they eat well but have fairly rigid conventions in their food consumption behaviour. The surprising negative value for E_1 under the logarithmic approach for Group 20 must be attributed to sampling fluctuations, and the value of 0·133 under the linear approach is almost certainly more reliable.

Under the linear approach the badly-off farm-labourers of Group 17 have a high income elasticity, as was to be expected, well above the constant value of 0·441 for the set given by the logarithmic approach. Other groups in Set A with similarly high income elasticities are the

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manual labourers of Groningen (Group 1), Enschede (Group 3) and Heerlen (Group 8), all of them big towns. Heerlen has the highest value of all, 0·582; being a mining town, its workers probably have the most physically arduous tasks, and it is logical that they should spend such a large proportion of any income increase on food.

Discussion of Household Size Elasticities

There is no such marked difference in the values of E_2 for the groups of Set B under the linear approach, but under the logarithmic approach those for farmers are markedly higher than the others, rising as high as 0·939 for Group 18. This is completely in accord with their behaviour with respect to income—any increase in household size is met by a nearly proportionate increase in food expenditure; there is hardly any restraint on quantity consumed in total, although the food consumed when household size is constant is unlikely to increase much if income rises.

Since the elasticities for the other Set B households are all but one above 0·5, under either approach, it seems that in middle income families there is always a sufficient margin of income to allow for what increase in food expenditure is necessary to meet an increase in household size. This again was to be expected, as from the group means it was deduced that a labouring class wage was enough to provide all the necessary food for the household. Thus a professional worker's earnings of double that, on the average, would have a considerable margin left when the essentials of existence have been paid for, and there would be no reason to stint food expenditure per consumption unit even if household size were to increase.

Since an E_2 of about 0·5 to 0·6 would seem to be a reasonable value for the household size elasticity, any lower income classes with much smaller values must be driven to considerable economies when the household is at all large. Such economies may be expected to consist of buying the cheapest quality food available and eliminating wastage in the kitchen as much as possible. Households where this is likely are those of farm labourers, with an elasticity as small as 0·318 under the linear approach, and workers in Enschede and Heerlen with values 0·321 and 0·376. From this and previous evidence, it appears these are the classes whose living standards are the most unsatisfactory; they would increase their proportionate food expenditure more than any other groups for a given increase in income, and must increase it least for a given increase in household size.

Summary of Results

(1) It is unsatisfactory to use only one regression equation for food expenditure on disposable income and household size for the complete range of income level and social class. This result was reached, although we had no information on the highest income levels, where discrepancies are likely to be greatest.

(2) In obtaining an equation with constant regression coefficients for differing groups of household, the logarithmic approach would seem more suitable for lower income levels and the linear approach for middle income levels. Farmers, whatever their actual incomes, are for this purpose best included in the second class.

(3) Differences in occupation class of the head of the household affect the regression coefficients mainly because they roughly determine the social and income class. Regional differences appear not to affect the coefficients greatly, but are associated with considerable differences in the average values of the variables in the different groups.

(4) For lower income groups E_1 varies from 0·246 to 0·582, and E_2 from 0·318 to 0·772, with the constant estimates at 0·441 and 0·450; for the middle income groups excluding farmers, E_1 ranges from 0·231 to 0·299 and E_2 from 0·546 to 0·680 (linear approach), while farmers have respective ranges 0·133 to 0·149 and 0·571 to 0·711 (again from the linear approach).

(5) Farmers consume most, relatively to their income, but are likely to be rather inflexible in their budget pattern and unlikely to change it much if their income is increased. A satisfactory level of food expenditure would seem to prevail amongst almost all classes. However, considerable economies in the food budget must be practised by the poorest workers with large households; the households in the worst position appear to be those of the poorer farm labourers and of manual labourers in large cities.

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APPENDIX

TABLE 1

Grouping of Families According to District (*Ia–IVc*) *and Occupation Class* (1–4)
(Families indicated by their Reference Number)

Occupation Class 1:

District *Ia*: 102, 142, 143, 148, 155, 156, 161, 176, 180, 188, 206, 209, 216, 222, 225, 228, 235, 239, 241, 248, 249, 250, 254, 255, 259, 289, 326, 330, 358, 373, 397, 401, 403, 424.
„ *Ib*: 56 (no calculation made).
„ *Ic*: 12, 37, 104, 109, 118, 170, 211, 227, 236, 299, 321.
„ *IIa*: 71, 78, 83, 107, 111, 122, 134, 149, 168, 178, 195, 204, 205, 219, 242, 245, 262, 264, 280, 288, 292, 294, 295, 315, 319, 320, 337, 341, 388, 395, 465.
„ *IIb*: 8, 73, 221, 357 (no calculation made).
„ *IIc*: 22, 25, 31, 62, 92, 135, 140, 154, 157, 182, 187, 196, 198, 237, 277, 279, 282, 302, 331, 359, 404, 472, 475.
„ *IIIb*: 28, 63, 76, 98, 238, 286, 306, 360 (no calculation made).
„ *IIIc*: 36, 39, 41, 44, 99, 201, 224, 260, 267, 317, 322, 327, 389, 427, 445, 450.
„ IVa_1: 80, 81, 91, 105, 125, 127, 159, 167, 174, 181, 202, 214, 217, 231, 243, 247, 257, 276, 287, 301, 308, 309, 324, 361, 371, 376, 377, 382, 392, 394, 430, 436, 458, 464, 469, 484, 513.
„ IVa_2: 23, 24, 35, 88, 89, 103, 112, 115, 116, 133, 139, 141, 144, 146, 160, 161, 169, 179, 220, 269, 275, 307, 356, 369, 379, 383, 451, 456, 471, 491, 505.
„ IVa_3: 27, 54, 58, 70, 100, 106, 124, 128, 164, 173, 175, 184, 185, 199, 213, 229, 230, 232, 233, 234, 265, 266, 273, 278, 290, 311, 318, 323, 329, 333, 336, 344, 365, 366, 367, 375, 386, 486.
„ *IVb*: 14 (no calculation made).
„ *IVc*: 13, 16, 17, 20, 21, 26, 30, 38, 51, 68, 74, 82, 87, 90, 94, 110, 120, 132, 138, 150, 151, 158, 171, 183, 190, 192, 200, 207, 212, 258, 261, 274, 281, 300, 305, 313, 314, 353, 355, 370, 417, 421, 453.

Occupation Class 2:

District *Ia*: 64, 131, 165, 215, 296, 297, 349, 364, 381, 398, 399, 412, 414, 416, 432, 454, 457, 530, 538, 572, 579, 581.
„ *Ib*: 244, 557 (no calculation made).
„ *Ic*: 285, 332, 343, 384, 407, 426, 429, 431, 462, 463, 492, 499, 501, 506, 519, 537, 542, 545, 546, 550, 551, 555, 564, 582, 588, 595.
„ *IIa*: 33, 284, 304, 340, 362, 410, 415, 442, 500, 539, 552, 569.
„ *IIb*: 460, 495, 512, 543, 559 (no calculation made).
„ *IIc*: 113, 153, 189, 208, 251, 372, 380, 396, 411, 419, 422, 439, 443, 449, 467, 479, 487, 490, 494, 498, 510, 511, 517, 522, 524, 540, 541, 548, 553, 554, 560, 570, 571, 573, 574, 586, 593.
„ *IIIb*: 291, 390, 406, 459, 488, 515, 549 (no calculation made).
„ *IIIc*: 252, 263, 271, 316, 334, 338, 374, 387, 391, 409, 438, 440, 455, 461, 474, 493, 514, 532, 533, 544, 547, 566, 577, 583.
„ *IVa*: 84, 130, 223, 347, 348, 351, 352, 363, 378, 402, 425, 433, 434, 441, 444, 447, 476, 477, 482, 483, 485, 496, 502, 509, 516, 520, 523, 525, 527, 535, 536, 558, 561, 562, 563, 565, 568, 575, 584, 585, 589, 590, 591, 594, 596, 597, 598.
„ *IVc*: 40, 117, 268, 312, 328, 346, 400, 420, 437, 446, 452, 478, 481, 489, 497, 503, 518, 529, 567, 576, 578, 580, 587.

Occupation Class 3:

District *Ib*: 3, 32, 34, 48, 53, 85, 96, 186 (no calculation made).
„ *Ic*: 19, 52, 55, 95 (no calculation made).
„ *IIb*: 4, 7, 9, 15, 29, 42, 43, 45, 47, 49, 60, 69, 101, 119, 126, 136, 172.

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District IIc: 77 (no calculation made).
„ IIIb: 6, 11, 18, 59, 61, 67, 72, 121, 210 (no calculation made).
„ IIIc: 10, 79 (no calculation made).

Occupation Class 4:
District Ib: 2, 177, 197, 203, 310, 350, 368, 405, 418, 428, 480, 521.
„ Ic: 193, 246, 253, 342, 448, 466, 592 (no calculation made).
„ IIa: 218 (no calculation made).
„ IIb: 50, 57, 65, 86, 93, 97, 114, 137, 145, 147, 152, 191, 194, 270, 283, 293, 298, 385, 408, 435, 504, 507, 508, 526, 531, 534.
„ IIc: 303 (no calculation made).
„ IIIb: 66, 108, 129, 240, 272, 325, 335, 339, 345, 354, 393, 413, 423, 468, 528.
„ IIIc: 1, 46, 123, 162, 226, 473 (no calculation made).
„ IVb: 5, 75, 163, 256, 470 (no calculation made).

Source: *Huishoudrekeningen van* 598 *Gezinnen*, Deel I (C.B.S., 's Gravenhage, 1937), tabel II, pp. 98/113 and p. 16.

TABLE 2

Municipalities Participating in the Survey, Grouped According to District

Municipality

District Ia: Groningen.
„ Ib: Bellingwolde, Finsterwolde, Uithuizen, Uithuizermeeden, Slochteren, Oldekerk, Barradeel, Franekeradeel, Kollumerland, Menaldumadeel, Baarderadeel, Haskerland, Wonseradeel, Wijmbritseradeel.
„ Ic: Appingedam, Ulrum, Veendam, Wildervank, Haren, Dokkum, Franeker, Harlingen, Idaarderadeel, Leeuwarden, Leeuwarderadeel, Rauwerderhem, Utingeradeel.
„ IIa: Enschede.
„ IIb: Borgen, Emmen, Gasselte, Dwingelo, Sleen, Westerbork, Dantumadeel, Weststellingwerf, Opsterland, Ooststellingwerf, Blankenham, Heino, Zwollerkerspel, Denekamp, Lichtenvoorde, Wisch, Avereest, den Ham, Ambt Hardenberg, Hengelo, Bathmen, Olst, Raalte, Steenderen, Wehl, Voorst, Buren, Maurik, Gieten.
„ IIc: Assen, Meppel, Goor, Bergh, Deventer, Harderwijk, Amersfoort, Hilversum, Arnhem, Nijmegen.
„ IIIb: Wieringerwaard, Hillegom, Beemster, Oterleek, Biervliet, Schermerhorn, N. and S. Schermer, Zoeterwoude, Strijen, Klundert, Borsselen, Kapelle, Kloetinge, St. Maartensdijk, Oosterland, Ovezande, Wemeldinge.
„ IIIc: Alkmaar, Oudorp, Haarlem, Oegstgeest, Vinkeveen, Zuilen, 's-Gravenhage, Rotterdam, Leiden, Leerdam, Giessen-Nieuwkerk, Hendrik Ido Ambacht, Nieuw Helvoet, Goes, Neuzen, Westkapelle.
„ IVa: Eindhoven, Tilburg, Heerlen.
„ IVb: Deurne, Uden.
„ IVc: Dongen, Geertruidenberg, Loon op Zand, Raamsdonk, Waalwijk, 's-Hertogenbosch, Geldrop, Amby, Maastricht, Brunssum, Hoensbroek, Kerkrade, Schaesberg.

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PROCEEDINGS OF SECTIONS

Industrial Applications Section

London Group

Thirtieth Ordinary Meeting, October 7th, 1949. Subject: Two Examples of the Control of Quality in the Manufacture of Electronic Tubes. Principal Speaker, Dr. E. A. G. Knowles. Chairman, Mr. A. Blackwell. Attendance, 31.

Dr. Knowles showed samples of the flares which are fused to C.R.C. tubes as feet and described the apparatus in which they were made. A close tolerance on the diameter of the flare was necessary because of subsequent assembly. Difficulty had been experienced because certain machines would go out of control for no obvious reason and later return to controlled production. The speaker described the investigations made to discover the cause (including the measurement of ingoing tube diameter) and how it was found to be a slipping of the tube in the grip which was not evident under ordinary conditions nor when the machine was stationary. By halving the length of tube fed in, and so reducing the weight to be opposed by the friction in the grip, the "out of control" periods were almost entirely eliminated.

Dr. Knowles described the methods of measurement adopted and gave a demonstration of the basis of a control chart which had been successfully used to instruct those concerned with the production in the case mentioned above.

After the discussion which followed Dr. Knowles gave a brief account of her second example—an investigation into the explosion of tubes under test. The results of the investigation were shown to the producing staff as a $2 \times n$ table ("broken" and "not broken," different thicknesses of wall) and the importance of minimum screen thickness was demonstrated.

Thirty-first Ordinary Meeting, November 4th, 1949. Subject: The Repeatability of Test Results. Speakers, Mr. G. Claxton, Mr. A. H. Dodd, Mr. J. R. Fraser, Mr. R. G. Newton, Mr. A. E. Worley, Mr. C. E. Rhodes. Chairman, Mr. A. Blackwell. Attendance, 60.

The speakers gave their experiences of the difficulties arising from discrepancies between test results on portions of the same material by different operators and different laboratories, and discussed the methods of dealing with the discrepancies—these were mainly by estimation of variances arising from the various sources. It was revealed that bodies such as the Institute of Petroleum and the Standardization of Tar Products Tests Committee were investigating, for the many tests with which they were concerned, the magnitude of the variances so that specifications could be adjusted and discrepancies occurring in practice checked for significance. Mr. Worley and Mr. Rhodes gave an account of a works test procedure which had been designed on statistical information thus acquired and which resulted in great savings, sometimes tenfold, in the times required for routine chemical tests for the control of quality.

An account of this meeting appears in *Nature*, February 11th, 1950.

Thirty-second Ordinary Meeting, December 2nd, 1949. Subject: Factorial Designs in Engineering Research. Principal Speaker, Mr. P. Eisenklam. Chairman, Mr. Philip Lyle. Attendance, 32.

The speaker dealt with the type of engineering experiment of which the design is rendered more difficult by having to be carried out on large-scale plant in ordinary operation. He stressed the advantages of factorial design in widening the validity of the conclusions and the necessity for randomization of all those effects which are to be included in "error" or "residual" variance. This last requirement may often conflict with the ordinary laboratory technique of "careful" observation as, for example, when attempts are made to keep the conditions of reading instruments constant. The speaker devoted some time to the exposition of a tabular method of entering results which facilitated subsequent computation of the analysis of variance. Although this required that factors should be used at equal intervals of level, he showed that because of the necessary spread in time it was possible to adopt a sequential choice of those levels, according to the results of earlier completed parts of the experiment.

A discussion followed on the value of such tabular methods, the necessity of randomization in time, the elimination of time trends and designs for dealing with large numbers of factors with some economy.

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North-Eastern Group

Twenty-second Ordinary Meeting, October 13th, 1949. Joint Meeting with the Institute of Industrial Administration. Subject: Statistical Aids to Administration. Principal Speaker: Mr. L. H. C. Tippett. Chairman: Mr. H. Robinson (of the Institute of Industrial Administration). Attendance: 53.

Mr. Tippett first gave a brief outline of what "management" meant.

An index of efficiency was management plus technical knowledge. This did not mean that the management must know all the technical needs of the organization. Technicians, however, must be able to submit the information in a concise form.

There was an art in handling masses of figures and in reducing the figures to data in a reasonable form. There was no standard form, and it was part of the statistician's job to devise charts and graphs that would give a true picture of the subject.

Much had been said about standard cost. The speaker was critical of this standard between factories in the same business and said that all factories which used "time and motion study," or "rate-fixing" as it was generally called, had their own basis of calculation, so that no true comparison could be made; to go further, standard cost internally could not be applied for the same reason. Mr. Tippett suggested that five "rate-fixers" rating the same job could vary their results by as much as 20 per cent.

In discussing important and irrelevant data, Mr. Tippett said that the main features of the subject being dealt with must always be kept in mind—it was easy to exaggerate an unimportant fact, which might throw a bias on the conclusions of the management. The statistician must take into consideration all the data and endeavour to give a true statement of facts. Mr. Tippett then illustrated the quality control chart technique used by Dr. Shewhart, of the Bell Telephone Company of America. Mr. Tippett used this method for examples of sales trends, sampling, etc. He advocated three main uses for it:

(a) *Occasional use*.—This could be interpreted as the first examination of a new process, normally used by "quality control" and discontinued when the process was in control. The technique could also be used for inter-factory comparison of labour efficiency.

(b) *Routine use*.—The use of the technique where records were continually being taken in the factory and where alterations to machines were necessary during a run.

(c) *Assurance and historical*.—In any routine check on the running of a machine or on new personnel to find out if there was any deterioration in the equipment or whether new personnel were handling the equipment in the best possible way.

The techniques briefly outlined in the talk had definite limitations. They did not tell the whole story and could be misleading, and the services of a statistician could be very useful in analysing the data.

In the discussion which followed, Mr. Tippett dealt with "sale trends," "rate-fixing" and many aspects of managerial problems.

Twenty-third Ordinary Meeting, November 23rd, 1949 (Joint Meeting with the Association of Supervisory Staffs, Executives and Technicians). Subject: The Presentation of Sample Data as a Guide to Executive Action. Principal Speaker, Dr. B. P. Dudding. Chairman, Mr. N. J. Squirrel. Attendance, 19.

For the benefit of a group of the audience who had no previous acquaintance with the statistics of sampling, Dr. Dudding opened his talk with a discussion of the various kinds of distribution of individuals in a population. He described common measures used in connection with sampling—the mean, range, and standard deviation. Using lantern slides to illustrate his examples, he showed the relation of the distribution of these measures in samples to those of the populations from which the samples were drawn.

To relate the theory to the conditions of industrial production he explained the construction of control charts and showed some charts used in glass-blowing. From the data on these, it was not difficult to infer the course of production and any changes in it which called for executive action.

Dr. Dudding gave other detailed examples dealing with furnace operation and with sales statistics.

Finally, he referred to other ways in which control chart and similar statistics could be used—in the value of charts to the man on the job, and in the value to management of a long-term record of production of some standard articles.

The talk was followed by a discussion covering the institution of a system of control charts and the cost of this kind of aid to management. In addition, Dr. Dudding developed at greater length some of the ideas he had previously been able to refer to only briefly, including the subject of fractional defective charts.

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TWENTY-FOURTH ORDINARY MEETING, January 18th, 1950. Subject: Charts and Correlation. Principal Speaker, Mr. D. G. Beech. Chairman, Mr. N. J. Squirrell. Attendance, 13.

In his introduction Mr. Beech said the elegant curves of the text-book did not always work out in practice and in many cases did not pass through all the points. It was thus often difficult to get a simple equation to fit them. What good were they and why did we draw graphs?

His opinion was that information could be more easily extracted from data presented in graphic form than from data presented in tabular form. The chart as against the graph consisted of plotted variables (temperature charts, quality control charts). In these cases either the region between the plotted points had no significance or we could make no valid predictions about it from available data—in other words, interpolation was not fractured.

Mr. Beech then demonstrated by examples on the blackboard and with the aid of slides how interpolation and extrapolation could be used to give more information about a problem, the plots on a chart, where one side had been obtained with high accuracy and the other side was known to have a considerable amount of experimental error.

TEES-SIDE SUB-GROUP

TWENTIETH ORDINARY MEETING, October 11th, 1949. Subject: Operational Research in War and its Extension to Industry. Principal speaker, Mr. T. A. Evans. Chairman, Mr. H. Kenney. Attendance, 24.

Mr. Evans began with the definition of Operational Research given by Sir Charles Goodeve.

He gave a brief review of the history of the subject and quoted some well known examples of the use of this technique, including Blackett's work at the Admiralty and the work of Bernal and Zuckerman on Home Security. He described in more detail work in which he himself had been concerned: (1) Studies in the efficiencies of weapons in France, and (2) Studies in supply and man-power in Burma.

He then discussed the extension of this technique to industry. He felt that a special section was required for this work. At the National Coal Board such a section existed and he was a member of the Field Survey Section. He considered that such problems as the following could usefully be tackled by Operational Research: The determination of the best methods of hauling coal (rope haulage, locomotive and belt); rock tunnelling; efficiency; price structure (of coal).

The discussion which followed showed the great interest taken in the subject.

TWENTY-FIRST ORDINARY MEETING, November 8th, 1949. Subject: A Study of Road Traffic Problems. Principal Speaker, Mr. J. G. Wardrop. Chairman, Mr. H. Kenney. Attendance, 14.

Mr. Wardrop said that the Road Research Laboratory began work on traffic problems in 1926. Previously little work had been done on these lines.

To study the problem one must observe two quantities: the density of traffic (flow) and the speed, the latter given by mean value and standard deviation. To make clear his meaning the speaker described a hypothetical example of a study before and after the introduction of a one-way system into a town.

He then described in some detail a survey of London Traffic carried out in 1947, using four cars on four routes. The plan was arranged so that every car had at the finish covered each route in each direction. A number of observations were made during each run and these were used to form a traffic map of the routes. The speaker discussed the effects of such factors as flow on speed in Central London; and the width of the road. He was able to obtain some useful relations between the factors.

Many members took part in the discussion which followed.

TWENTY-SECOND ORDINARY MEETING, December 6th, 1949. Subject: Experimental Design. Principal Speaker, Mr. G. E. P. Box. Chairman, Mr. H. Kenney. Attendance, 16.

Mr. Box pointed out that modern statistical design of experiments originated in the work of Fisher and Yates at Rothamsted in the 1920's. In their work, which was primarily concerned with agriculture, designs fixed in advance and adhered to as rigidly as possible were suitable. There were problems in the Chemical Industry which were suited to this type of design. Many of them, however, required new techniques, and some of these were still being developed.

The speaker discussed the technique of randomized blocks and showed how it was applied in an investigation into the wearing of rubber. He discussed Factorial Designs and described how, when there were a large number of factors, they could be planned in such a way that all the important factors could be examined without carrying out all the possible combinations of factors. He described briefly some of the newest developments.

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TWENTY-THIRD ORDINARY MEETING, January 10th, 1950. Subject: Increasing Efficiency in American Steel Plant Operations. Principal Speaker, Mr. D. R. G. Davies. Chairman, Mr. T. W. Hurst. Attendance, 20.

The speaker had been in North America during last year to visit steel factories and to study the extent and value of their use of statistical methods. At this meeting he talked of what he had seen and discussed how far American ideas could be applied in British factories.

At one Canadian factory quality control charts were in use giving the percentage of defective material and similar charts showing factors which might affect the quality. Orders were given that the factors should be brought and kept under control and it was found not only that percent. defective came under control but that the average was considerably reduced.

Other examples were then given of the use of quality control methods in factories. The most important feature which was stressed by Mr. Davies, was that these charts were kept and studied with interest by the ordinary workpeople.

Turning to the more advanced techniques Mr. Davies discussed some of the problems being examined by means of regression and correlation methods. He said that considerably fewer firms were using these methods. In discussing the use of experiments designed on statistical lines he said that Government Departments were making much use of them but very few Steel Plant laboratories were doing so.

He summarized his impressions by saying that the Americans consider statistical methods and quality control hold a very important position in their work. He stressed, however, the danger of collecting a considerable amount of data and not attempting to make use of it.

SHEFFIELD GROUP

TWENTY-SIXTH ORDINARY MEETING. September 29th, 1949. Subject: The Application of Statistical Methods in American Steel Plants. Principal Speaker: Mr. D. R. G. Davies. Chairman: Mr. W. T. Hale. Attendance: 24.

Mr. Davies described a number of simple applications of statistical and numerical reasoning to problems in the plant, emphasizing that the foreman was instrumental in carrying them out; without his full co-operation at all stages in the problem, failure would undoubtedly have resulted. He commented, too, on the large number of control charts which were kept; the usual practice was to stabilize the variability of the process by running control charts on all the variables associated with it, and the improved stability so gained appeared to result in a general improvement in the quality of the output of a plant.

After describing some attacks by the qualified statistician, this time on problems of greater complexity, Mr. Davies concluded by giving the following rules which summarized what he had learnt from his American experiences:

(1) Ascertain the object of the investigation.
(2) Ask whether this object is being attained, and if it is not, scrap and start again.
(3) Establish right relationships with all the people concerned.
(4) Ensure that the source of the data is accurate.
(5) Ensure that the methods used are not unnecessarily refined.

TWENTY-SEVENTH ORDINARY MEETING. October 27th, 1949. Subject: A Symposium on the Scope of Statistics. Chairman: Mr. A. W. Swan. Attendance: 19.

The following subjects were discussed: "A Control Chart in the Foundry," by Mr. W. J. Colton; "The Use of Statistics in Safety-in-Mines Research and Testing Branch," by Mr. J. G. Dawes; "Statistics and Some Properties of Coal," by Mr. P. H. Price; "An Application of Statistics to Price Estimation," by Mr. J. Russell.

TWENTY-EIGHTH ORDINARY MEETING, November 10th, 1949. Subject: A Symposium on the Teaching of Statistics. Chairman, Mr. W. T. Hale. Attendance, 22.

Mr. F. L. Moxon, representing the Mathematical Association, spoke as a teacher in a Grammar School. Of his 35 teaching periods he devoted two to statistics and 33 to other mathematical subjects. This was more than was generally allocated to the subject in schools; in few schools was there any time at all. He prepared candidates for the Higher School Certificate subsidiary subject, "Mathematics and Elementary Statistical Method"—a subject due to disappear next session—and lamented that the mathematics set had nothing to do with the statistics and was uniformly disliked by the candidates because of its scrappiness. He outlined the proposals for statistics in the new syllabuses for the General Certificate, and pointed out that its absence from the Advanced Mathematics and Theoretical Mechanics meant that no students with real mathematical inclinations would be studying it.

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On the general subject of teaching statistics in schools, he felt that the ideal was a general course for everyone in Form 6—both arts and science students—a course which included an explanation of such elementary but commonly met devices as bar charts, circular diagrams, and time series graphs (the latter illustrating trend and cycle), a discussion of index numbers, with a fairly detailed study, say, of the Ministry of Labour Interim Index of Retail Prices, death rates and vital statistics and simple properties of frequency distributions and correlation; he would also advocate the inclusion of hints of the existence of such major problems as those arising in sampling, without any attempt to develop detailed theory. This course, being non-mathematical, would help the pupils to appreciate the value and to comprehend something of the meaning of the statistics which assailed them from all sides in later life, and would tie up well with subsequent studies in economics, geography, or science. The absence of mechanical aids to computation prevented much actual analysis being done in any school course.

He was conscious of the lack of breadth in his own statistical experience and felt acutely, as other teachers similarly placed would probably feel, the lack of an elementary text-book with a wide variety of examples drawn from a large number of different fields. He had wasted much time hunting for such examples in more advanced text-books.

Mr. L. T. Wilkins, representing the Study Section, thought that students learned statistics, not in order to have their minds trained, but to pass examinations and then obtain jobs. There was a lack of liaison between examiner and employer, much of it because what the employer wanted was not clearly understood; employers were vague, feeling simply that "statistics were useful for proving things." He was a statistician, and his teaching was evening class work with students for B.Com., Inter. Statistics and the Diploma of Public Administration. He felt that in examinations such as these questions should occasionally be set to test whether the student knows the limitations of his knowledge of statistics; he felt, too, that since the immediate need of employers was for practical statisticians, students not aware of these limitations and possessing only a working knowledge would meet trouble when confronted with situations where the validity of the assumptions used in applying the working knowledge was in question.

He felt that mathematical teachers tended to lack practical experience, and so failed to train their students to apply statistics; the non-mathematical ones tended to lack theoretical knowledge and thus failed to induce a critical outlook on the methods themselves. Sources and criticism of their value should be introduced at a low level; there was a circular element in some of them which should be appreciated.

Mr. G. H. Jowett said that, as a university teacher, he was fortunate in examining his students himself. He outlined the courses he gave at the University of Sheffield: a mathematical course for final year honours mathematics students, with as much practical work as possible (but little enough), an introductory course for B.A.(Econ.) and first year honours economics students, a course for post-graduate and final year honours students in science and applied science subjects, and an extra-mural course attended mainly by teachers and industrial research workers. Other teachers gave specialized courses, one for engineers, one for education students. He felt that the most useful teaching of statistical methods such as regression, analysis of variance, and kindred topics was most profitably given to the more mature students, who had a little experience of the problems of research and could appreciate the need for such methods when it was pointed out to them; at lower levels, the most valuable teaching was of topics such as those which Mr. Moxon had mentioned together with illustrations of such things as bias in questionnaire responses, selection, nonsense correlations, and similar problems involving little technique but a critical attitude. He criticized the content of elementary syllabuses in that they presented much material which had little virtue of itself; for example, they usually included the standard deviation as a measure of dispersion, but no sampling theory, leaving the student with a measure which seemed to him vague, to have no virtues over a more easily interpreted interpercentile range, and to be tiresome in the calculation; it was also conventional to teach the quartiles, though other percentiles were much more widely used, and nowadays much more practically useful. He did not feel that the fact that these measures might be useful in a subsequent course justified their inclusion in the elementary course, especially if the students would in all probability never take the subsequent course.

Mr. A. W. Swan said that his grumble as an employer of statistically instructed students was that they could rarely tell him in an interview what statistics was really about. They usually knew the theory and techniques, and this, of course, was very necessary knowledge; but they failed, in general, to appreciate the fundamental purpose of the subject, which put them at a serious disadvantage when attempting to apply it. To be useful, the statistician must not only know the theory but must be really interested in applying what he knows. This lack of practical outlook was the fault of the present methods of teaching statistics. It might be partly overcome if students were encouraged to spend part of their vacations in such departments as his own, in close contact with practical applications and their peculiar difficulties.

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In the subsequent discussion Mr. Turner said that the course which he gave to undergraduate engineering students was one of many courses on non-engineering subjects about which engineering students had to know a little; it was designed mainly so that they should know when to call in a statistician, just as an electricity course taught them when to call in an electrician. Mr. Miles, who gave technical college courses for the diplomas of the I.I.A. and the B.I.M. on "Statistics as a tool of management" complained of the low level of education, with little mathematics, of many of his students, a situation which made such things as ratio graphs on logarithmic paper difficult for them to comprehend. He tried to impress on them that while statistics would occasionally enable them to draw an unexpected conclusion, its main use was to prevent the drawing of unwarranted conclusions. Mr. Murdoch, supported by the chairman, said that he felt that simple properties of experimental error might profitably be discussed in very elementary laboratory work in schools. Mr. Bradford, supported by Mr. Turner, said that he felt that the mature student learned statistics very much more rapidly than the immature, also the former needed statistics for critical reading of published work. Mr. Ellison, Mr. Austwick, and the opening speakers also contributed to the discussion.

TWENTY-NINTH ORDINARY MEETING. November 24th, 1949. Subject: The Development of Mechanical Sampling of Raw Materials in a Modern Ironworks. Principal Speakers: Mr. D. Ward and Mr. E. Nixon. Chairman: Mr. W. T. Hale. Attendance: 15.

Mr. Nixon spoke first, giving an account of the problems of sampling from the metallurgist's point of view. After outlining the general sampling problem, he described the technique of increment sampling—size, disposition and shape, and number of increments. Describing the Robins-Messiter system of bedding ore, he gave details of the sampling methods appropriate to these beds. Next, he gave an account of a curious wavelength effect observed in sampling from the belt of a reclaiming machine, and described the reduction of a 400 lb. sample to laboratory samples. He concluded by discussing the methods of sampling sinter strength and blast furnace bunkers.

Mr. Ward then gave the statistical background of these techniques. He showed how analysis of variance was used to supply estimates of components of variance, and how these were used in sample design. He gave an account of the fitting of the wavelength effect by the function $a \cos \alpha + b \sin \alpha$. Finally, he discussed a ranking test for comparing components of variance, and the optimum number of replications in sinter sampling.

Six members spoke in the general discussion.

SOUTH WALES GROUP

FIRST ORDINARY MEETING, October 14th, 1949. Subject: The Use of Statistics in Psychological Testing. Principal speaker, Dr. J. W. Cox. Chairman, Dr. T. V. Starkey. Attendance, 20.

The speaker dealt with the limitations of testing and the reasons why it sometimes came under suspicion. He explained the technique of percentile ranks and the technique of correlation. The audience included personnel officers and educationalists. The talk was followed by a keen discussion.

SECOND ORDINARY MEETING, November 11th, 1949. Subject: The Use of Statistical Method in Steel Plants in the U.S.A. Principal speaker, Mr. D. R. G. Davies. Chairman, Dr. T. V. Starkey. Attendance, 25.

This paper was also given at a meeting of the Sheffield Group and is reported in the Proceedings of that Group.

THIRD ORDINARY MEETING, December 9th, 1949. Subject: The Use of Calculating Machines in Statistical Computing. Principal speaker, Dr. J. C. P. Miller. Chairman, Dr. T. V. Starkey. Attendance, 40.

The talk, which was well demonstrated, dealt with the use of calculating machines of various types in mathematical work. A number of methods were described of preparing the data in such a way as to effect a substantial reduction in the amount of computing necessary, and a selection of appropriate machines and the methods of operating them were dealt with in connection with numerous types of problems.

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REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

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1.—*The Registrar General's Statistical Review of England and Wales for the Six Years* 1940–1945. Text. Vol. I, Medical. London: H.M.S.O., 1949. vi, 388 pp. 9¾″. 6*s.* 6*d.*

In the years before 1939 the Registrar General's *Statistical Review of England and Wales* consisted of three parts, Parts I and II (Medical and Civil Tables) and a Text volume. Delays in preparation and printing caused by the war led to a departure from the pre-war procedure, and this Text volume covers the six years 1940–1945 and deals only with medical statistics. This has provided a unique and most interesting survey of the mortality trends of England and Wales during an abnormal period. A corresponding Text volume dealing with the civil statistics of these years will be published later.

The value of this Text has been considerably enhanced by discussions on a number of new features in addition to those topics providing continuity with earlier volumes. These include the classification of causes of death according to the Fifth Decennial Revision (1938) of the International List of Causes of Death from 1940 onwards, a revised and simpler method of selecting from "joint causes" of death, the introduction of the Comparative Mortality Index in 1940 as a more suitable standardization procedure, the calculation of infant mortality rates based on related instead of registered live births, the use of data obtained since the Population (Statistics) Act, 1938, in the analysis of maternal mortality, the improvement in statistics of notifiable infectious disease, the effects of selecting men for the armed forces upon death-rates of the civilian population, the progress of the diphtheria immunization campaign, and analyses of accidents in the home, motor traffic fatalities and deaths of civilians by enemy action.

In the six years 1940–1945 the deaths of 1,604,446 males and 1,474,104 females were registered in England and Wales. These totals include deaths of 55,867 male and 1,093 female non-civilians. For civilians only the resulting crude annual death rates per 1,000 living were: 1940, 14·36; 1941, 13·54; 1942, 12·31; 1943, 13·00; 1944, 12·73; 1945, 12·61.

The population of 1901 is no longer a good standard for calculation of standardized death-rates owing to the great change in proportionate age distribution since that date. The substitution of another fixed standard more closely resembling the present population would have few advantages, and the Registrar General therefore introduced in 1940 the Comparative Mortality Index. For any given year this is the ratio between the standardized death-rate for that year to that for 1938, each based on the mean of the proportionate age-distributions of the populations living in 1938 and the year in question. The following figures show the trends of the C.M.I. for all causes at all ages in males and females from 1938 to 1945:

Year	*Comparative Mortality Index (1938). All ages*	
	M.	*F.*
1938	1·000	1·000
1939	1·016	1·028
1940	1·187	1·156
1941	1·096	1·043
1942	·967	·916
1943	·978	·944
1944	·952	·894
1945	·920	·875

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The number of deaths registered as caused by operations of war in the successive years 1940 to 1945 were 23,268, 18,539, 3,798, 2,986, 9,460 and 2,269, the highest number in any quarter being 14,826 in the December quarter of 1940, followed by 10,942 in the June quarter of 1941.

Owing to the rapid shortening of the interval between birth occurrence and registration, from about 30 days in 1939 to under 12 days in 1943 and later, and to the great changes in the number of births in a year, the assumptions made in using registered live births as the denominator of infant mortality rates were no longer valid, and it became necessary to calculate these rates per 1,000 related live births. The infant mortality rate of 50·6 per 1,000 related live births in 1939 increased in 1940 and 1941 to 56·8 and 60·0 respectively, then declined in successive years, the rates being 50·6, 49·1, 45·4 and 46·0. It is pointed out that the rates for these last two years give no cause for complacency when in the same years New Zealand had rates of 30 and 28, Australia 31 and 29, Sweden 31 and 30, with U.S.A. (White), South Africa and Switzerland also comparing very favourably with England and Wales. The improvement in England and Wales from 1942 onwards was confined to two distinct age periods, the first week and the second half of the first year, the former probably resulting from the special attention devoted to expectant mothers during the war. The stillbirth rate fell from 37·2 per 1,000 live and still births in 1940 to 27·6 in 1945. Owing, probably, to the effects of enemy action the infant mortality rate for county boroughs showed an excess of 19 per cent. over the national rate during the period 1940–42 compared with 14 per cent. excess in 1938, 1939 and again in 1943–45, but despite its severe trials Greater London did not show such a relative increase. Prematurity and bronchitis and pneumonia remained the two commonest causes of death of infants. The neonatal rate from haemolytic disease of the newborn, a special sub-group distinguished since 1940, increased steadily from 1940 to 1945, but this was probably due to more careful diagnosis, with the increasing interest in the role of the Rh factor in its causation.

Apart from an increase in 1941 the death rates for children aged 1–5 declined steadily from 1940 to 1945, reaching a level less than half that in 1931–35. Average annual rates for 1944–45 compared with 1938–41 show a percentage decrease of 71 for diphtheria, 62 for scarlet fever, 56 for measles and 52 for whooping cough. The epidemic of cerebro-spinal fever in 1940 and 1941 caused rates of 248 and 221 per million living at these ages compared with rates ranging between 20 and 85 in normal years. Tuberculous meningitis remained an important cause of death, with a rate of 276 per million in 1940, increasing to 384 in 1941, then declining to 254 in 1945. The respiratory tuberculosis rate increased from 44 per million in 1940 to 77 in 1941, and then remained practically stationary in succeeding years at about 60.

By 1945 the death rates, exclusive of deaths due to operations of war, for boys and girls of school age had declined well below the levels for 1936–39. The most striking change for children 5–10 years was the decline of the diphtheria death rate by 79 per cent. Whereas in 1936–39 it was the principal cause of death at this age, by 1945 it was third in order of importance after violence and tuberculosis. At ages 10–15 violence accounted as in pre-war for more deaths of boys than any other cause, and in girls it moved from fourth place in the pre-war period to second in 1941–42 and in 1945. Tuberculosis ranked second for boys, and was the chief cause of death for girls in each year 1940–45.

At ages 15–20 mortality for both sexes rose slightly from 1936–39 to 1940 and 1941 and then fell during the remaining war years, the decline of female rates being greater, since it was not affected like the male rate by the removal of a quarter of their number to the services. The mortality trend for females 20–25 years was similar to that for 15–20 years, but the male mortality was seriously affected by physical selection, the civilian population only containing 29 per cent. of the total males 20–25 years by 1945. The rate therefore increased from 2·77 per 1,000 in 1936–39 to a level around 4·7 from 1941 onwards. The civilian male rates for tuberculosis (all forms), heart disease and rheumatic fever, nephritis (all forms), cancer and epilepsy were in 1945 over twice those in 1939.

At ages 25–50 the male civilian death rate, owing to physical selection into and discharge from the services, increased as the war progressed, affecting one age group after another as successive groups were called up. For the diseases mentioned above it is estimated that this selection had the effect of withdrawing from the population men with a potential death rate only one-fifth that of the average man of that age, while for the age-group 15–45 the combined effect of these selections was to take and keep in the services men whose average rate of mortality (not directly due to operations of war) would have been 53 per cent. of the average rate for their age if all had remained in civilian conditions of life. How much of this selection was accomplished by rejection and how much by subsequent discharge cannot be estimated.

In 1940 all the sex-age groups over 50 showed considerable increases over 1936–39 rates but then fell substantially, reaching levels in 1942 far below those of 1936–39; by 1945 further improvement had occurred except for males 60–65 and females 70–75 and 80–85. Cancer and the "de-

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generative" group of causes of death (consisting of cerebral, coronary and myocardial disease and senility) formed an increasing proportion of the total for both sexes, though in females the rates were falling, and substantial absolute increases were seen only for males 50–65. Causes more amenable to medical treatment or to preventive measures, such as pneumonia and diabetes, showed considerable reduction in their rates during the war period.

From 1940 onwards deaths were classified according to the Fifth Revision (1938) of the International List of Causes of Death. A more important change lay in the method of selecting the primary cause of death when more than one cause was mentioned on the death certificate, the arbitrary rules previously used being superseded by selection based on the opinion of the doctor who issued the certificate. This change has since been given world-wide approval by its embodiment in international regulations adopted by the World Health Organization. For diseases such as diabetes and heart diseases, which under the arbitrary rules carried a high priority, the effect has been a considerable reduction in the number of deaths ascribed to these causes, while for chronic bronchitis, often associated on a death certificate with heart disease, there has been a substantial increase. By a dual tabulation of deaths in 1936–39 according to the new and old procedures, and allowing also for the revision of the International List, a series of conversion ratios were calculated which applied to deaths and rates prior to 1939 would make these comparable to tabulations by the procedure adopted in 1940. The conversion process was carried out in full detail of sex and age in presenting trends in the Reviews from 1931 onwards to the war years, and some of the ratios for the principal causes of death for all ages were published in the *Statistical Review*, Part I, Medical, for 1940.

Defects of certification of death are discussed under the following headings: (1) Inaccuracy of diagnosis, particularly in rural areas and for young infants; (2) omission of the real cause of death because its appearance on the register may be unpleasant or inconvenient to relatives, as, for example, with deaths from syphilis or chronic alcoholism; (3) faulty statement on the certificate of the certifier's opinion as to the relative parts which several causes played in producing the fatal issue; (4) inadequate information on the cause, type of injury, the part of the body affected and place of occurrence of fatal accidents.

The sections of this Text devoted to specific diseases also contain much of interest. Measles and whooping-cough became notifiable throughout the country in 1940. It is estimated that 57 per cent. of children born may be expected to be notified for measles before reaching age 15. It is doubtful whether the true measles risk for the whole country before age 15 exceeds 70 per cent., and therefore notification may be more complete than generally supposed, while fatality rates for these children based on notifications may not be overstated by more than one-third. On the other hand, according to 1944 rates only about 16 per cent. of children would be notified for whooping cough before reaching age 15. This disease probably escapes notification in large measure, but to what extent could not be estimated. The diphtheria death rate, which was already falling before the war, declined more rapidly still from 228 per million living under 15 years in 1939 to 67 per million in 1945, this reduction being related to the progress of the diphtheria immunization campaign, which by the end of 1945 had artificially immunized not less than 60 per cent. of the children under 15.

Dysentery notifications, which were about 4,000 in 1937 and in 1938, increased year by year to over 16,000 in 1945. After 1942 this rise was not accompanied by a corresponding increase in deaths, and might be accounted for either by an increasing prevalence of mild forms or by more complete notification. For tuberculosis the total deaths showed an arrest of the downward movement in 1939, a considerable increase in 1940–41, a return of the 1938–39 level in 1942–43, and thereafter a resumption of the downward trend. The effect of the war on female death rates from respiratory tuberculosis at all ages was to hold up the downward progression by four or five years. For males the rates were grossly affected by civilian selection.

The introduction of sulphonamides just before the war resulted in the striking reduction in fatality rates from cerebro-spinal fever from about 80 per cent. in 1931–37 to about 30 per cent. in 1940 and throughout the war. Mortality from pneumonia at all ages decreased steadily throughout the war probably from the same cause, the fall being considerable except for the very young and very old. Lobar pneumonia rates appeared to be much more affected by the new drugs than broncho-pneumonia rates. The ageing of the population resulted in cancer deaths among older persons forming an increasing proportion of the total mortality, but except among children or males aged 35–65, where the rates were still increasing, cancer mortality for all sites at specific ages showed a downward trend. In contrast to those for any other organ rates for cancer of the lung, bronchus and pleura rose rapidly and continuously at every age period for each sex, the increase for males being greater than for females. It is suggested that this trend cannot be completely accounted for by the greater frequency of X-ray examination of the chest in those thought to be suffering from other lung diseases, such as tuberculosis, pneumonia or bronchitis. Probably

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related to dietary changes and food rationing mortality from diabetes at all ages fell during the war years, the C.M.I. for males in 1945 being ·721, for females ·770. A striking exception to this trend was for females aged 15–35. Mortality from exophthalmic goitre showed a pronounced improvement during the war which it is difficult to explain, the large rural excess of pre-war years being maintained. Crude death rates from intracranial lesions of vascular origin increased by a quarter from 1937 to 1945, but the C.M.I. for each sex decreased slightly in the same period, indicating an apparent increase due to changes in the age-structure of the population. For both sexes the C.M.I. for coronary disease and angina pectoris increased 86 per cent. in the ten years 1935 to 1945. Increases in the mortality from coronary and arteriosclerotic heart disease were partly offset by a decline in mortality from other myocardial degeneration and senility, indicating what was probably a transfer from one to the other group by changing fashion in certification.

The reduction in maternal mortality which began in 1935 continued without interruption throughout the war. In 1939 the rate due to pregnancy and childbearing without abortion was 2·57 per 1,000 live and still births, in 1940 2·24 and in 1945 1·47. The rate due to infections of childbirth and the puerperium fell from 0·55 per 1,000 live and still births in 1940 to 0·24 in 1945, continuing the pre-war trend largely due to sulphonamides and penicillin, but originating before their introduction. The large-scale development of blood transfusion services and of antenatal and postnatal care was probably responsible for much of the reduction in maternal mortality not due to infections. Although deaths due to and associated with abortion showed about the same relative fall as maternal deaths between 1936 and 1945, until 1945 there was no improvement in the frequency of deaths from post-abortive sepsis. In 1940–45 more than a quarter of these deaths were known to be the result of non-therapeutic interference with pregnancy. From information supplied by the Population (Statistics) Act, 1938, it was possible to calculate the maternal risk at different ages, this being least at ages 20–25, 1·27 per 1,000 live and still births in 1940–45, and increasing with the age of the mother to 8·12 at over 45 years of age.

J. K.

2.—*Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death*. Vol. I. Geneva: World Health Organization, 1948. London: H.M.S.O. xxvii, 376 pp. 9½″. 2 vols. 30*s*.

This *Manual*, while faithfully following the tradition of previous International Lists of Causes of Death, is far more than a revision of its predecessor. For the first time it has been specifically designed to serve as a classification of diseases and injuries as well as causes of death. Equally important, the Sixth Decennial Revision Conference saw the *Manual* as but one of the means to achieve an extensive programme of international co-operation in health statistics.

The history of the development of the International List of Causes of Death has been recorded in previous *Manuals*. The need for extension of this classification to suit morbidity statistics was recognized by Farr, who prepared his "Report on Nomenclature and Statistical Classification of Diseases," and it is interesting to note that in 1860 Florence Nightingale urged the adoption of his classification for use with hospital statistics. Limited expansions of the International List of Causes of Death to adapt it for use with morbidity statistics found little general acceptance, and the Fifth Decennial Revision Conference in 1938 recommended the preparation of an international list of diseases and further study of the appropriate statistical treatment of joint causes of death. Meanwhile several countries found it necessary to prepare statistical classifications of diseases and injuries; the Dominion Council of Health of Canada in 1936, the Medical Research Council in England and the Division of Public Health Methods of the United States Public Health Service in 1944 each formulated morbidity codes. In 1945 the United States Government, in accordance with the resolution of the Fifth Decennial Revision Conference, appointed the Committee on Joint Causes of Death which had representatives of the Canadian and British Governments as members and consultants. This Committee, taking a very wide view of its responsibilities, recognized firstly that the joint-cause problem applies to both mortality and morbidity statistics, and secondly that there should be a single list for classifying both types of statistics. The Committee therefore prepared a proposed classification for morbidity and mortality statistics.

In 1947 the Expert Committee of the Interim Commission of the World Health Organization was set up to prepare for the decennial revision of the International List of Causes of Death, and the establishment of an international list of causes of morbidity. This Expert Committee reviewed and revised the proposed classification of the U.S. Committee on Joint Causes of Death, and with a special Sub-committee on Index submitted its proposals to the Sixth Decennial Revision Conference in Paris in April, 1948. With minor amendments the classification was unanimously approved, and its publication recommended to the World Health Assembly in the form of the present *Manual* as the International Statistical Classification of Diseases, Injuries and Causes of Death.

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The basis of this new classification is the Detailed List, which contains 612 categories of disease and morbid conditions, with 153 categories for external cause of injury and 189 for classification of injuries according to the nature of the lesion. A decimal system of numbering designates each category by a three-digit number, the first two digits of the number usually indicating important or significant summary groups. The third digit divides the group into specific diseases or according to sub divisions indicating, for example, anatomical site. Thus, numbers beginning with the digits 49 represent "Pneumonia," the sub divisions being 490 "Lobar pneumonia," 491 "Bronchopneumonia," 492 "Primary atypical pneumonia," and 493 "Pneumonia, other and unspecified." As an example of anatomical sub division, numbers beginning with the digits 15 represent "Malignant neoplasm of digestive organs and peritoneum," and the categories numbered 150 to 159 therefore represent ten divisions of such malignant neoplasms by specific site within the digestive organs and peritoneum—the oesophagus, stomach, small intestine, etc. The numbers used are not always consecutive, so that new categories may be introduced without upsetting the basic numbering of other categories. The greater flexibility and utility of this numbering system compared with former methods is also claimed for clerical and mechanical handling.

There are seventeen main sections in the Detailed List compared with eighteen in the Fifth Revision. Some comparatility has been secured for important categories with the previous International List, but this has not been considered essential for each individual subdivision. To preserve continuity the Sixth Decennial Conference recommended that deaths for the year 1949 or 1950 for the country as a whole should be coded according to the Detailed List of 1948 and to the Fifth Revision of 1938, dual tabulations being published to indicate the changes resulting from the application of the new List.

A new important section in the List is that entitled "Mental, Psychoneurotic and Personality Disorders," which reflects the new purpose of the List. The treatment of the section "Accidents, Poisonings and Violence" is particularly interesting, a dual classification being employed in which the two parts are not mutually exclusive. Categories in this section are numbered 800–999, the number being prefixed with the letter "E" when the External Cause classification is used, and by the letter "N" when the Nature of Injury classification is indicated. Thus, E 820 N 820 represents a "Motor vehicle traffic accident while boarding and alighting," the injury sustained being "Fracture of neck of femur."

An essential part of the List is the Tabular List of Inclusions which shows the diagnostic terms included within each category of the Detailed List. In the Tabular List many of the three-digit categories have been further subdivided into four-digit categories which do not appear in the Detailed List, and are important and useful though optional. As an illustration, category 325 in the Detailed List represents "Mental Deficiency," which the Tabular List of Inclusions shows is made up of sub-categories "Idiocy" number 325.0, "Imbecility" 325.1, "Moron" 325.2, "Borderline intelligence" 325.3, "Mongolism" 325.4, and "Other and unspecified types" 325.5. All terms appearing on medical records and death certificates cannot be included in this Tabular List, and obsolete and unsatisfactory terms and infrequent diagnoses appear only in the Alphabetical Index which constitutes volume 2 of the *Manual*.

As a large proportion of medical records and death certificates show more than one cause, the problem arises whether it is desired to count the number of persons who are sick or have died or to count the conditions that produced the illness or death. Both tabulations are important, though it is usual in mortality tabulations to assign a single cause to each death, basing the tabulation on the individuals who have died. Certain principles have developed for selecting this single cause. Many countries have used the *United States Manual of Joint Causes of Death*, while in England and Wales specific but more flexible rules were in use until 1939. A new form of death certificate introduced in England in 1926 permitted the certifying physician and surgeon to signify more clearly the order of events leading up to death, and in 1940 the arbitrary rules were superseded by selection based on the opinion of the certifier where more than one cause was mentioned. The Sixth Decennial Revision Conference recommended an International Medical Certificate of Cause of Death and Rules for the Selection of the Underlying Cause of Death, adopted by the World Health Assembly, both of which are based on British procedure since 1940. These are designed to select the disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury. The Conference further recommended that one multiple-cause tabulation be prepared by each country around the census year.

The problem of classifying morbidity data is more complex, and before international rules could be prepared it was recognized that more consideration had to be given by all countries to the various aspects of morbidity and to the specific purposes to be served by the statistics.

It is emphasized that morbidity and mortality records should always be coded according to the Detailed List of three-digit categories, but this detail will not always be required in tabulation.

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Three special lists are given for this purpose: List A—Intermediate List of 150 Causes for Tabulation of Morbidity and Mortality; List B—Abbreviated List of 50 Causes for Tabulation of Mortality; List C—Special List of 50 Causes for Tabulation of Morbidity for Social Security Purposes. In these lists the three-digit categories included in each tabulated cause group are clearly indicated.

As an example of international co-operation the preparation of this *Manual* is outstanding. Perhaps even more remarkable in these days is that the Nomenclature Regulations of the World Health Organization which govern its use and application required no ratification, but automatically applied to each Member unless notice of rejection or reservation were made to the Director-General. J. K.

3.—Papers of the Royal Commission on Population, Vol. 1. *Report of an Enquiry into Family Limitation and its Influence on Human Fertility During the Past Fifty Years.* By E. Lewis-Faning. London: H.M.S.O., 1949. xvi, 202 pp. 9¾". 4*s*.

This enquiry was planned to answer the following questions:

(1) How extensively is birth control practised?
(2) In what proportions are the different methods of birth control practised?
(3) Are there important differences between different social groups in the extent of the practice of birth control, or in the choice of the methods?
(4) To what extent is birth control, as practised, effective?
(5) What is the extent of involuntary infertility?
(6) Does the practice of birth control affect the power to reproduce?
(7) How important is abortion as a method of birth prevention?
(8) What is the proportion of "unplanned" pregnancies?
(9) What is the proportion of "unwanted" children?
(10) What are the chief reasons given for using birth control?

The investigation was conducted by the Royal College of Obstetricians and Gynaecologists at the request of the Royal Commission on Population since they were the most suitable body to obtain information relating to the reproductive histories of women. The intimate nature of the questionnaire necessitated a careful approach to secure the co-operation of the women to be interviewed. This ruled out any idea of obtaining a random sample by the usual means. It was decided that only qualified members of the medical profession who stood to the women in the relation of doctor to patient would be successful as interviewers.

The problem of obtaining a representative sample without introducing any bias presented great difficulties. Three main methods of contact were decided on: the general wards of hospitals (non-maternity); maternity cases; general practice contacts, etc. 11,078 questionnaires were completed but it was found that the method by which the majority of these were collected introduced a bias and the analysis was confined to 3,281 women, 2,821 of whom were patients in the general wards and 460 derived by other means. The resulting sample cannot be taken as representative of the general population of married women since the great majority was drawn from three areas: 42 per cent. from London, 28 per cent. from Glasgow, and 16 per cent. from Yorkshire West Riding.

The questionnaire contained 31 headings and many of these included several subsidiary questions. Some of the answers depended on the ability of the women to remember the date of occurrences of several years earlier. How much reliance can be placed on the answers to these questions is problematical, but Dr. Lewis-Faning, the author of this report and who was also responsible for the statistical analysis, was impressed by the "general truthfulness and accuracy" of the answers. Whether this is wholly an impression or whether there was any evidence to support this belief is not stated.

An extensive analysis of the data was made and the report includes 127 tables. The principal sub-divisions made were by age, date of marriage, birth controller and non-controller, and by social class. A comparison of the data with the Registrar General's five social classes in 1931 showed a deficiency in classes I, II and V. In the report three social groups depending upon the occupation of the husband were used: class I included the Registrar General's classes I and II and the non-manual workers of class III; class II were the skilled manual workers of the Registrar General's class III, and class III comprised the Registrar General's classes IV and V.

A steady increase was found with date of marriage in the percentage of women who had used birth control at some time during their married life. About two-thirds of the women married in recent years had practised birth control, while only 15 per cent. of the women married before 1910 had done so. This latter proportion seems unduly small when it is remembered that the

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birth rate had fallen rapidly in the 40 years preceding 1910. Generally, birth control was reported more extensively in the highest social class but some exceptions were found for various periods. The proportion of women using appliances has increased during the past 30 years while the proportion relying on coitus interruptus has decreased. The use of appliances has become more general in each of the three social classes, although their use increases, and coitus interruptus decreases, as one ascends the social scale. Despite the increased use of birth control the percentage of women reporting unwanted children has risen from 6 per cent. of all children born to women married before 1910 to 14 per cent. for those married in 1930–34. One-quarter of the fourth and later children have been unwanted since 1920–24. There was a social gradient in the proportion of unwanted children, for the percentage of unwanted third children born to women married in 1930–34 was 31 for social class I, 20 for social class II, and 18 for social class III. 24 per cent. of the women who planned the size of their family at marriage had an unwanted child while 23 per cent. of the women who did not plan their family size had an unwanted child. In contrast to the unwanted child, 45 per cent. of the women over age 45 wished they had more children and only 9 per cent. would have preferred fewer children. For the large family of 5–7 children, 18 per cent. of the mothers would have preferred more and 19 per cent. would have preferred fewer, while for families of 8 or more, 15 per cent. of the mothers would have preferred more and 38 per cent. fewer children. No significant differences existed between the three social classes in the proportion of women who would have preferred more, less, or the same number of children as they actually had. 12 per cent. of the women married before 1925 and who had never practised birth control were childless. Over one-half of these childless women did not seek medical advice and slightly less than one-half of the women who sought advice were given no treatment.

An attempt was made to assess the importance of abortion as a method of birth prevention. For various reasons, in particular the penalties attached to criminal abortion, the abortion rate found must be accepted with caution and it is probably below the true level. 11·4 per cent. of all pregnancies terminated in an abortion, and of these 8·7 were claimed to be spontaneous. There was a distinct social class pattern for criminal abortions, as a percentage of all pregnancies varied from 2·3 per cent. in social class I to 1·0 in social class III. Drugs were the favourite method used and accounted for 54·1 per cent. of the total admitted number of attempts at abortion, while douches were used in 25·4 and instruments in 11·5 per cent. of abortions. The use of drugs varied from 42·9 per cent. in class I to 66·7 per cent. in class III, while the use of douches ranged from 35·7 in class I to 22·2 in class III. The self-induced abortions formed 63 per cent. of the admitted attempts in class I, 71 per cent. in class II and 89 per cent. in class III. The remaining abortions were procured by another person.

The tabulation of the reasons given for not using birth control by the 1,412 women in the non-controller group (more than one reason was stated in many cases) showed that 42 per cent. of the women wanted a family and did not mind how many or how quickly they came, 26 per cent. wanted a family but could not get it, 12 per cent. had a fatalistic attitude to the arrival of children, 10 per cent. pleaded ignorance of birth control methods. Religious objections to birth control were only mentioned in 8 per cent. of the comments. Analysis by social class showed that the proportion of women who wanted a family and could not get it was highest in class I, while ignorance and religious objections were pleaded to the greatest extent by class III. The reasons given by the controller group for using birth control, showed that 38 per cent. of the women stated they could not afford (more) children, and 25 per cent. used control to space pregnancies at appropriate intervals. Rather surprisingly only 4 per cent. of the women stated that ties and loss of freedom were their reasons.

W. J. M.

4.—*Descriptive Mathematics.* By J. Maclean. Oxford University Press, 1946. 2nd ed. xiv, 95 pp. 8¼″. 8*s.* 6*d.*

In his Preface the author states: "Though the setting of this book is that it constitutes in the University of Bombay a course in mathematics optional to the usual post-matriculation syllabus, and though as such it is easily available in its present form for adoption in most Indian universities wherever there are suitable teachers, yet the outlook has not at all been confined to Indian conditions: the endeavour has been to sift out the kind of mathematics that will be of use to any modern student." The most varied contents ranges from efficient arithmetic, slide rule and nomograms to statistical sufficiency and exact distributions, touching on the way partial differentials, numerical integration and stereography. With this wide range of diverse topics the book cannot aim at training an applied mathematician, nor, indeed, teaching a non-mathematician how to use mathematical tools, although such a claim seems to have been made in the Preface. All that

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can be claimed is to convey a bird's eye view of "What of Mathematics ?" consisting of scattered, somewhat disjointed but amusing "hints," not based on a logical structure. Its asset is the vigorous variety, and the emphasis is on oddities rather than on the usual approach.

Thus, in the chapter on Statistics (Chapter 5) a first section on averages and measures of dispersion is immediately followed by one (5.1) dealing with such advanced topics as efficient and consistent statistics, representative sampling, bias, etc., which, if understood, can only convey the most superficial indication of what these concepts are about. It is impossible to convey such weighty matters on a single page of (sometimes faulty) verbal description. The same applies to section (5.42) on skewness and kurtosis, which also contains a mysterious reference to the *t*-distribution.

The reviewer has enjoyed reading the Preface, in which some interesting views on the teaching of mathematics are skilfully expounded. H. O. H.

5.—*A Statistical Study of India's Industrial Development.* By N. S. R. Sastry. Bombay: Thacker & Co., 1947. 14, 191, 1 pp. 9¾". *Rs.* 12.8.

This book was a thesis for a Doctorate degree of the University of London, submitted in 1942. Owing to the War its publication was delayed until 1947, when it was already somewhat out-of-date. The author, however, has wisely added an all-too-brief postscript of six pages showing the important changes in industrial development brought about during the War. The study really covers the period 1900 to 1937 and is limited to seven industries only—cotton, jute, sugar, iron and steel, cement, paper, and coal. Each industry is examined from the viewpoint of localization, the size of industrial units, the development of the industry, its increase or decrease in production and, last of all, the problem of labour is discussed. As Dr. Sastry points out, it is a far cry from the first establishment of a cotton mill in Bombay in 1853, a jute mill near Calcutta in 1855 and the construction of the East India railway to the coal regions of Raniganj in 1854. The main value of the work is that it points out how industrial development in India has benefited since it became a highly protective country after the report of the Fiscal Commission of 1921. The structure of the import trade has altered. Imports of articles of general consumption, especially cotton goods, as Lancashire knows only too well, have fallen heavily, while the imports of capital goods, raw materials and luxury goods have increased. Exports, on the other hand, have been confined mainly to raw cotton, raw jute and jute manufactures, tea, hides and skins, and food grains. The population, however, of the country has grown at such an enormous rate that India has now for some years been an importer of food. In the postscript it is clear that World War II has given an impetus to the strengthening of the industries covered by Dr. Sastry's study. There was, however, a great handicap owing to difficulties connected with the import of machinery and machine parts, and the Government of India did not, as the Governments of Canada and Australia, encourage the establishment of heavy and armament industries.

The characteristic feature of the study is the skilful use made of the statistical material available, especially in measuring industrial production in Chapter V. There are tables showing fluctuations, industry by industry, about the general trend and the logarithmic trend in terms of standard deviation, and these are suggestive. Methods of measuring industrial location (which Dr. Sastry takes to be "the degree of dissimilarity between the geographical distribution of the industry and the population") lead to several conclusions. Thus, if the basis for assigning a particular industry to a particular locality is taken as one-half of the total number of employees in the industry, the cotton industry may be said to be localized in Bombay, jute and paper in Bengal, sugar in the United Provinces and iron and steel and coal in Bihar. No industry is localized in Madras, the Punjab and the Central Provinces. The frequency distribution of location factors is taken for the year 1937, the last year of the enquiry, with the class interval 0·5 with reference to industrial population and total population, and it is found that jute, iron and steel, paper, coal and cement are confined to only a few regions, while the cotton industry is found in all regions, and after cotton, sugar, although in many sugar is of little importance. These examples are typical of the way in which Dr. Sastry has utilized statistical methods to get at the facts.

There has been almost a revolution in the decade on labour and labour problems, a revolution which has been most marked in Bombay. The worker has not yet been, as in this country, weaned away from his village or birthplace, and he goes to Bombay or other centres of industry to amass some savings and to return as soon as possible. Conditions in industry were, until recent decades, very unsatisfactory, but with the support of Trades Unions a great change has taken place in regard to the level of wages, housing and conditions of employment. Unfortunately, the inflation of recent years has increased the cost of living and considerably nullified wage increases. Nevertheless, in not a few cases conditions are even better for the workers than for the educated or so-called "black-coated" employees. One result—and an important result—of all these changes

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has been the increased attention paid to the importance of cost-of-living indices and to national income and wealth statistics.

Dr. Sastry's study, like Mr. R. C. Desai's paper on "Consumer Expenditure in India," read before the Society in 1948, shows how much is being done in Indian statistics and indeed how much still remains to be done. The good work of the Indian Statistical Institute under Professor P. C. Mahalanobis, F.R.S., is indicative of the same forward movement. It is unfortunate that Dr. Sastry's work does not deal with India apart from Pakistan, but this was, at the time of writing, impossible. It would, however, be useful if Dr. Sastry would follow up this study with a short handbook showing the development of India's industries, its capital, formation, location, etc., apart from those of Pakistan, so that those interested in the future development of industry inside and outside India could have up-to-date statistics in readily available form. Perhaps this might be done under the aegis of the Reserve Bank of India, to which Dr. Sastry is now attached.

G. F. S.

6.—*Bourne's Book of Squares.* By J. B. Bourne. Georgetown, British Guiana: The Daily Chronicle Ltd., 1946. v, 5 pp. $13\frac{3}{4}''$. 5*s*.

This booklet gives the squares for all integers x from 1 to 10,099. They are arranged as two-way tables in which x is split into the form $x = 100\,a + b$, and b and $100.a$ must be looked up as line- and column-headings. The square x^2 is then printed in the form $x^2 = A\,10^4 + B\,10^2 + C$ with B given in the body of the table, whilst the leading figures A must be read by passing up the "indented" column and the end-figures C are given on the left-hand margin. No answers are provided if b is a multiple of 10 and the reader is asked to form $(x/10)^2\,100$ instead.

The economy of 25 per cent. in space achieved by the above arrangement hardly warrants the complication in use, which is particularly awkward if and when interpolation is needed.

H. O. H.

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STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices compiled by the Ministry of Labour and National Service moved fractionally month by month between August and January, 1950. The cumulative effects were to raise the index, which is quoted to the nearest whole number, by 1 point in September and by a further point in December. The food index rose by 4 points in the period, due to increases in the prices of certain vegetables and fruit and to increases in the price of bread and flour following devaluation. The clothing index fell slightly late in September, due to reductions in the price of some Utility articles. There was also a slight rise in the fuel index, due to increases in gas and electricity prices in some areas. The figures for other groups of items showed little change in the period. The detailed figures for August to January were as follows:

(Prices at June 17th, 1947 = 100)

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Drink and Tobacco*	*Total*
Weights . .	348	88	97	65	71	35	79	217	1,000
Aug. 16th, 1949 .	116·0	100·1	118·7	112·9	108·3	113·1	105·4	107·5	111
Sept. 13th ,, .	116·8	100·1	119·1	113·2	108·2	113·1	105·5	107·5	112
Oct. 18th, ,, .	119·0	100·3	116·8	113·8	107·9	113·1	105·6	107·5	112
Nov. 15th, ,, .	118·9	100·3	116·9	114·1	108·0	113·1	106·1	107·5	112
Dec. 13th, ,, .	119·5	100·3	117·1	114·7	108·1	113·1	106·1	107·5	113
Jan. 15th, 1950 .	120·3	100·4	117·1	115·1	108·1	113·6	106·1	107·5	113

In publishing the figures the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e. to the nearest first place of decimals. The decimals are shown only in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attributed to the decimals, and for any other purposes, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates, which rose from 108 to 109 in June, remained at that figure to the end of the year but rose fractionally in January, 1950. The following is a summary of the figures since June, 1947, when the present series was instituted.

(Wage Rates at end of June, 1947 = 100)

Date (end of month)	*Men*	*Women*	*Juveniles*	*All Workers*
June, 1947	100	100	100	100
Sept., ,, ...	101	101	102	101
Dec., ,, ...	103	103	106	103
Mar., 1948	105	106	107	105
June, ,, ...	105	107	108	106
Sept., ,, ...	106	108	109	106
Dec., ,, ...	107	109	110	107
Mar., 1949	108	110	111	108
June, ,, ...	108	111	111	109
Sept., ,, ...	108	111	112	109
Oct., ,, ...	109	112	112	109
Nov., ,, ...	109	112	112	109
Dec., ,, ...	109	112	112	109
Jan., 1950	109	113	113	110

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The total working population and the numbers in civil employment shown by the new series of manpower figures, which became available early in 1949, are as follows:

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Mid-1948 . . .	16,057	7,089	23,146	14,945	6,981	21,926
June, 1949 . . .	16,023	7,171	23,194	15,079	7,078	22,157
July, „ . . .	16,036	7,169	23,205	15,095	7,075	22,170
Aug., „ . . .	16,056	7,197	23,253	15,113	7,099	22,212
Sept., „ . . .	16,068	7,210	23,278	15,122	7,108	22,230
Oct., „ . . .	16,083	7,241	23,324	15,129	7,126	22,255
Nov., „ . . .	16,099	7,285	23,384	15,141	7,166	22,307
Dec., „ . . .	16,074	7,244	23,318	15,109	7,113	22,222

It will be seen that between June and December, 1949, the total working population showed an increase of 124,000, 51,000 males and 73,000 females. The number in civil employment was 65,000 higher in December than in June.

The level of unemployment rose by 110,887 between August and January. The largest monthly increase was 41,930 in January.

Number of Unemployed Persons on the Registers of the Employment Exchanges of the Ministry of Labour and National Service

Date	*Men and Boys*	*Women and Girls*	*Total*
Aug. 15th, 1949 . . .	194,216	67,173	261,389
Sept. 12th, „ . . .	199,377	68,489	267,866
Oct. 10th, „ . . .	219,635	80,620	300,255
Nov. 14th, „ . . .	233,893	89,716	323,609
Dec. 5th, „ . . .	238,753	91,583	330,336
Jan. 16th, 1950 . . .	262,771	109,495	372,266

The total for January, 1950, includes 51,091 married women. The totals do not include registered disabled persons who were classified as suitable only for employment under sheltered conditions.

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(2) Other Statistics

In 1947 the Economic and Social Council recommended that the United Nations publish "a demographic yearbook, containing regular series of basic demographic statistics, comparable within and among themselves, and relevant calculations of comparable rates . . ." *The Demographic Yearbook 1948* has been prepared by the Statistical Office of the United Nations in collaboration with the Department of Social Affairs, and is now available from H.M. Stationery Office at a price of 50*s*. This Yearbook is intended to replace, in due course, the various non-comprehensive compilations which have been issued in the past. Of the 39 tables presented in the first issue, 12 deal with population statistics (enumerated or estimated numbers, age, sex, marital status, etc.), 18 with vital statistics (live births, deaths and death rates, marriages), 4 with reproduction rates and life tables, and 5 with international migration. The tables are drawn mainly from the period 1932–1947, and vary considerably in completeness. Many important items have had to be omitted, and it is hoped to include these in later issues of the *Yearbook*, together with additional and revised data on the subjects treated in the first issue.

The volume contains nearly 600 pages, including 70 pages of explanatory text, 470 pages of tables, and a valuable bibliography listing more than 1,000 titles of official sources of demographic statistics throughout the world. The entire text, including footnotes to the tables, is printed in both English and French, and the publishers are to be congratulated on the clarity of the presentation of both the tables and the text. The series will be of great value as an authoritative reference work on international statistics.

The office of the Economic Adviser to the Government of India has recently made available Volume III of the *Guide to Current Official Statistics*. This volume deals with public finance, education, public health, the census, labour, consumption of commodities and miscellaneous

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items. Volume I dealt with production and prices and Volume II with trade, transport and communications and finance. These compilations are all based on the statistics as they existed before partition. A combined edition of the Guide is expected which will also contain alterations made necessary as a result of partition. The present volume is divided into three parts: (1) Descriptive Guide; according to main headings of the subject matter, (2) Index of Publications; in alphabetical order with page references to the subject matter as arranged in the Guide, (3) Subject Index; in alphabetical order with page references to the place where it is first mentioned in the Guide. There is also a system of reference symbols to the publications for which a key is given in an appendix. This also affords a valuable cross-reference into the Index of Publications. These three parts will undoubtedly help any user in this country to find a way through these important official statistics.

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STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Biometrika—

December 1949—The estimation of the parameters of tolerance distributions: *D. J. Finney.* An overlap problem arising in particle counting: *P. Armitage.* Tables of autoregressive series: *M. G. Kendall.* Tables for use in comparisons whose accuracy involves two variances, separately estimated: *A. A. Aspin.* (With an appendix by *B. L. Welch.*) Bivariate distributions based on simple translation systems: *N. L. Johnson.* A test for randomness in a sequence of two alternatives involving a 2×2 table: *P. G. Moore.* A general distribution theory for a class of likelihood criteria: *G. E. P. Box.* Note on approximations to the power function of the "2×2 comparative trial": *G. P. Sillitto.* The distribution of "Student's" t in random samples of any size drawn from non-normal universes: *A. K. Gayen.* The combination of probabilities arising from data in discrete distributions: *H. O. Lancaster.* Note on the application of Fisher's k-statistics: *F. N. David.* The moments of the z and F distributions: *F. N. David.* The method of frequency-moments and its application to type VII populations: *H. S. Sichel.* On the Student's t-test in an asymmetrical population: *S. G. Ghurye.* Tables of symmetric functions—Part I: *F. N. David* and *M. G. Kendall.* On the efficiency of the method of moments and Neyman's type A distribution: *L. R. Shenton.* Large-sample theory of sequential estimation: *F. J. Anscombe.* A historical note on the method of least squares: *R. L. Plackett.* The characteristic function of a weighted sum of non-central squares of normal variates subject to s linear restraints: *G. I. Bateman.* Intra-class rank correlation: *J. W. Whitfield.* A note on non-normal correlation: *J. B. S. Haldane.*

British Journal of Social Medicine—

July 1949—Visual tests of fatigue in operational flying: *D. D. Reid.* The care of the chronic sick: *C. R. Lowe* and *T. McKeown.* A study of the efficiency of groups of ex-miners disabled by pneumoconiosis employed in light industries in S. Wales: *J. A. P. Treasure.* Variations in energy expenditure during walking: *C. Delbue, R. Passmore, J. Thomson* and *J. A. Watt.*

Eugenics Review—

January 1950—Intelligence and fertility: *Sir G. Thomson.*

Institute of Actuaries, Journal—

Vol. LXXV, Part I, No. 340—Presidential address: *Sir G. Maddex.* The distribution of sickness: *L. E. Coward.* The relation between the distribution of sickness and the effect of duplicates on the distribution of deaths: *R. E. Beard* and *W. Perks.* Hospital and medical care coverage in the United States of America: *A. Hunter.* An investigation into the mortality of diabetic patients attending the diabetic clinic of King's College Hospital: *A. J. Steeds.* The recent trend of mortality in England and Wales: *W. S. Hocking.*

Oxford Economic Papers—

January 1950—Evaluation of real national income: *P. A. Samuelson.* Measurements of efficiency: *L. C. Hawkins.* Prices and costs in nationalized undertakings: *C. A. R. Crosland.* Note on the price policy indicated by the Nationalization Acts: *D. N. Chester.* The commercial crisis of 1847: *C. N. Ward-Perkins.*

Royal Sanitary Institute, Journal—

Vol. LXX, No. 1—The common cold: *W. H. Bradley.*

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INDIA—

Sankhyā—

September 1949—A theoretical system of selection for homostyle *primula*: *R. A. Fisher.* On some problems arising out of discrimination with multiple characters: *C. R. Rao.* On certain aspects of spring balance designs: *K. S. Banerjee.* United Nations Economic and Social Council Sub-Commission on Statistical Sampling: Report to the Statistical Commission. Recommendations concerning the preparation of reports of Sampling Surveys. Comparability of measurements: *K. P. Chattopadhyay.*

UNITED STATES—

American Economic Review—

December 1949—A theory of delivered price systems: *G. J. Stigler.* The problem of capital accumulation rejoinder: *E. H. Stern.* Monetary policy formation: *G. L. Bach.* Discrimination in international trade: *F. D. Holzman.* International aspects of a recession: *A. O. Hirschman.* The theory of price of storage: *H. Working.*

American Statistical Association, Journal—

December 1949—Statistics of the Kinsey Report: *W. A. Wallis.* The city block as a unit for recording and analyzing urban data: *E. B. Olds.* The relation of the net reproduction rate to other fertility measures: *T. J. Woofter.* On estimating the mean and standard deviation of truncated normal distributions: *A. C. Cohen, Jr.* On some mathematical problems arising in the development of Mendelian genetics: *H. Geiringer.* The fitting of logistic curves by means of a monograph: *E. A. Rasor.* On the best choice of sample sizes for a *t*-test when the ratio of variances is known: *J. E. Walsh.* Note on some errors in "The Evidence of Periodicity in Short Time Series": *A. A. Alchian.*

Annals of Mathematical Statistics—

December 1949—Locally best unbiased estimates: *E. W. Barankin.* A sequential decision procedure for choosing one of three hypotheses concerning the unknown mean of a normal distribution: *M. Sobel* and *A. Wald.* Moments of random group size distributions: *J. W. Tukey.* The power of the classical tests associated with the normal distribution: *J. Wolfowitz.* Application of the method of mixtures to quadratic forms in normal variates: *H. Robbins* and *E. J. G. Pitman.* The joint distribution of serial correlation coefficients: *M. H. Quenouille.* On the estimation of the number of classes in a population: *L. A. Goodman.* Concerning compound randomization in the binary system: *J. E. Walsh.* The distribution of extreme values in samples whose members are subject to a Markhoff chain condition: *B. Epstein.* Note on the consistency of the maximum likelihood estimate: *A. Wald.* On Wald's proof of the consistency of the maximum likelihood estimate: *J. Wolfowitz.* A note on random walk: *H. T. David.* Numerical integration for linear sums of exponential functions: *R. E. Greenwood.* Smoothest approximation formulas: *A. Sard.* On the power function of the "best" *t*-test solution of the Behrens-Fisher problem: *J. E. Walsh.* A note on Fisher's inequality for balanced incomplete block designs: *R. C. Rose.*

Biometrics—

December 1949—The choice of a response metameter in bio-assay: *D. J. Finney.* The validity and meaning of the results of biological assays: *N. K. Jerne* and *E. C. Wood.* A biological assay of tuberculins: *R. A. Fisher.* On a one-dimensional diffusion method of assaying antibiotic substances and its fundamental formulas: *M. Masuyama.* Routine computation of biological assays involving a quantitative response: *M. J. R. Healy.*

Estadística—

September 1949—Segundo Congreso Interamericano de Estadística. Censo de Viviendas en las Américas: *A. Casis.* Agricultural population: suggested tabulation procedures: *FAO.* Claves de codificación sugeridas para país de nacimiento, nacionalidad y lengua: *O. A. de Moraes.* La Cartografía para los Censos en Costa Rica: *M. B. Ferrero.* The consumer's price index for moderate-income families in large cities in the United States: *C. P. Stallings.* Oportunidades para los estadísticos en la industria: *J. B. Catlin.* La Presentación de variaciones estacionales a los directores de empresas: *A. S. Donnahoe.*

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Second Session of the Committee on the 1950 Census of the Americas, Rio de Janeiro, D.F., February 14–25, 1949: Resolutions. Funcionamento del Centro Latinoamericano de Capacitación Estadística y Censal, México, D.F., 1948. Disposiciones legales sobre el Censo de 1950: Brasil, Venezuela.

Journal of Political Economy—

December 1949—The Marshallian demand curve: *M. Friedman.* Liquidity and a national balance sheet: *R. N. McKean.* Mathematical economics before Cournot: *R. M. Robertson.*

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. II, Part 2—Die Faktorenanalyse in der Psychologie: *W. Toman.* Wer ist der Komponist?: *K. Schubert.*

Vol. II, Part 3/4—Einführung in die Sequential Analysis: *L. Schmetterer.* Zur Anwendung der Varianzanalyse in der Biologie: *H. Wenzl.* Randbemerkungen zum Varianzbegriff: *A. Adam.* Über die Stirling'sche Fakultätenformel: *E. Michalup.* Die "Lebenserwartung der Gestorbenen": *W. Winkler.* Das erweiterte "Paretosche Gesetz" und seine ökonomische Bedeutung: *W. Winkler.* Statistik und Sportforschung: *A. Adam.* Politische Kennzahlen der österreichischen Nationalratswahlen: *W. Winkler.*

BELGIUM—

Bulletin de l'Institut de Recherches Économiques et Sociales—

November 1949—La conjoncture économique de la Belgique: *L. H. Dupriez.*

December 1949—Unité de l'anthropologie culturelle: *J. J. Maquet.* La déchéance de la puissance paternelle: *H. Hanquet.* Perspectives de l'étude de l'opinion publique belge: *F. van Mechelen.*

FRANCE—

Population—

October–December 1949—Les théories démographiques dans l'Antiquité grecque: *J. Moreau.* Aperçu démographique sur l'évolution des effectifs scolaires: *P. Vincent.* Structure et dynamique des populations sauvages de vertébrés: *F. Bourliere.* Mortalité, profession et situation sociale: *J. Daric.* Pologne: dix années d'histoire démographique: *G. Frumkin.*

Revue d'Économie Politique—

July–August 1949—Les grandes invasions et le commerce européen: *R. Gonnard.* La comptabilité nationale et les corrélations: *J. Dumontier.*

GERMANY—

Mitteilungsblatt für Mathematische Statistik—

Vol. I, Part 3—Biologische Gesetze im Lichte der Mathematik: *M. P. Geppert.* Zur Methodik der Aufstellung von kurzen, praktisch verwendbaren Familiennamenschlüsseln: *H. Strebel.* Ein einfaches Stabilitätsmass und seine Anwendung in der Versicherung: *P. Riebesell.* Die typischen Schlusswisen der mathematischen Statistik. 3. Teil: *H. Münzner.* Elementare Ausführungen zur Theorie und Technik des Stichprobenverfahrens. 1. Fortsetzung: *H. Kellerer.*

Weltwirtschaftliches Archiv—

Vol. 63, Part 2—Anomalien im Zahlungsbilanzmechanismus: *J. Tinbergen.* Sozialistische Wirtschaftsverfassung: *G. Mackenroth.* Geldpolitische Erfahrungen der dänischen Anti-Inflationspolitik: *G. Schleiminger.*

HOLLAND—

Statistica—

Vol. 2, No. 4—Een methode van contrôle tijdens de fabricage: *F. G. Willemze.* Critiek op de "Hyperbolische Foutenwet": *D. H. G. Brethouwer.* Een schattingsproef: *V. Varangot.*

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ITALY—

Statistica—

July-September 1949—Analisi della distribuzione sulla proprietà fondiaria (II parte): *A. de Polzer.* Considerazioni sul metodo della popolazione tipo: *L. Galvani.* Aspetti economici e statistici della "borsa nera" in Italia (II parte): *A. Giannone.* Le caratteristiche territoriali del prelievo forestale legnoso in Italia: *D. Miani-Calabrese.*

SWEDEN—

Ekonomisk Tidskrift—

December 1949—Sambeskattningsfrågan (*med* 4 *st. lösa diagramblad*): *G. Lindgren.*

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LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part III, 1949, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Air Ministry, Meteorological Office. Percentage frequencies of various visibility ranges at certain places in the British Isles between the years 1927 and 1936. London, H.M.S.O., 1949. 52 pp. 9½″. 1*s.*

Colonial Office

Colonial Annual Reports, 1948: Bahamas. 47 pp. 8¼″. 2*s.* Barbados. 66 pp. 8¼″. 2*s.* British Guiana. 110 pp. 8¼″. 2*s.* 6*d.* British Honduras. 49 pp. 8¼″. 2*s.* 6*d.* Cyprus. 54 pp. 8¼″. 2*s.* Dominica. 44 pp. 8¼″. 1*s.* 6*d.* Gibraltar. 48 pp. 8¼″. 2*s.* Gilbert and Ellice Islands. 40 pp. 8¼″. 1*s.* 6*d.* Hong Kong. 159 pp. 9¼″. 10*s.* 6*d.* Mauritius. 136 pp. 8¼″. 4*s.* Nigeria. 135 pp. 8¼″. 3*s.* North Borneo. 72 pp. 8¼″. 3*s.* Nyasaland. 61 pp. 8¼″. 2*s.* St. Helena. 48 pp. 8¼″. 2*s.* St. Lucia. 62 pp. 8¼″. 2*s.* Sarawak. 94 pp. 8¼″. 6*s.* Sierra Leone. 62 pp. 8¼″. 2*s.* Singapore. 166 pp. 8½″. 10*s.* 6*d.* Zanzibar. 56 pp. 8¼″. 1*s.* 6*d.* London, H.M.S.O., 1949.

Inter-university Council for Higher Education in the Colonies, second report, 1947–49. London, H.M.S.O., 1949. Cmd. 7801. 17 pp. 9½″. 6*d.*

Report of a commission of enquiry into the sugar industry of British Guiana. (Colonial No. 249.) London, H.M.S.O., 1949. x, 184 pp. maps. 9½″. 4*s.*

East African Rice Mission. Report on rice production in the East and Central African colonial territories, 1948, by Gerald Lacey and Robert Watson. (Colonial No. 246.) London, H.M.S.O., 1949. 78 pp. maps. 9½″. 6*s.*

Commonwealth Economic Committee. Thirty-third report: a review of commonwealth trade. London, H.M.S.O., 1949. iv, 53 pp. 9½″. 1*s.* 6*d.*

Ministry of Education. Report of the Working Party on the Supply of Women Teachers. London, H.M.S.O., 1949. iv, 19 pp. 9¾″. 6*d.*

Ministry of Food. Food consumption levels in United Kingdom. London, H.M.S.O., 1949. Cmd. 7842. 13 pp. 9½″. 4*d.*

General Register Office

Estimates of the sex and age distribution of the civilian population in regions and administrative areas of England and Wales at 31st December, 1947. London, H.M.S.O., 1949. ii, 50 pp. 13″. 2*s.* 6*d.*

National registration of England and Wales, 1939. Population statistics of county boroughs, municipal boroughs, urban districts, rural districts and civil parishes ... London, G.R.O., for official use only. [2] 143 fols. 13″.

Health, Ministry of

Housing Manual, 1949. London, H.M.S.O., 1949. 150 pp. 9¾″. 3*s.* 6*d.*

National Health Service Act, 1946. Hospitals' directory, England and Wales, October, 1949. London, H.M.S.O., 1949. 164 pp. 9¾″. 3*s.*

Health, Ministry of. Department of Health for Scotland. Report of the Working Party on the chairside times taken in carrying out treatment by general dental practitioners in England, Wales and Scotland. London, H.M.S.O., 1949. 77 pp. 9½″. 1*s.* 6*d.*

Labour and National Service, Ministry of

Cotton Manufacturing Commission. Final report of an inquiry into wages arrangements and methods of organisation of work in the cotton manufacturing industry, parts II, III and IV. London, H.M.S.O., 1949. 87 pp. 9½″. 1*s.* 6*d.*

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Tables relating to employment and unemployment in Great Britain, 1948. Regional and industrial analysis. London, H.M.S.O., 1949. 27 pp. 11″. 1*s.* 6*d.*

London County Council. The L.C.C. Hospitals: a retrospect. L.C.C., 1949 (No. 3675). 158 pp. 7¼″. 7*s.* 6*d.*

Royal Commission on Population. Papers of the Royal Commission on Population, Volume I. Report on an enquiry into family limitation and its influence on human fertility during the past fifty years, by E. Lewis-Faning ... London, H.M.S.O., 1949. xvi, 202 pp. Questionnaire on fertility 17 pp. 9¾″. 4*s.*

Royal Commission on the Press. Index to minutes of oral evidence. London, H.M.S.O., 1949. Cmd. 7690. 12 pp. 9½″. 3*d.*

Scotland, Department of Agriculture for. Investigation into the economics of milk production in Scotland. Report No. 2 (1946–7). Edinburgh, H.M.S.O., 1949. 23 pp. 9½″. 6*d.*

Trade, Board of

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Pursuant to the Act 7th and 8th Victoria, cap. 32 (1844)

(000's omitted)

1	2	3	4	5	6	7	8
		Issue Department				Collateral Columns	
Liabilities	Dates (Wednesdays)	Assets					
Notes Issued		Govt. Debt (£11,015) and Govt. Securities	Other Securities	Gold Coin and Bullion*	Silver Coin†	Notes in Hands of Public	Minimum Discount Rate
£		£	£	£	£	£	
1,300,248	Jan. 5	1,299,238	749	248	13	1,272,333	2%
1,300,248	„ 12	1,299,284	705	248	11	1,251,290	
1,300,248	„ 19	1,299,288	702	248	9	1,234,117	
1,300,248	„ 26	1,299,192	798	248	10	1,224,502	
1,300,248	Feb. 2	1,299,286	703	248	10	1,227,175	
1,300,248	„ 9	1,299,209	779	248	12	1,230,152	
1,300,248	„ 16	1,299,306	684	248	11	1,228,537	
1,300,248	„ 23	1,299,285	705	248	10	1,228,030	
1,300,248	Mar. 2	1,299,232	757	248	11	1,233,369	
1,300,248	„ 9	1,299,275	712	248	13	1,240,246	
1,300,248	„ 16	1,299,199	791	248	10	1,242,442	
1,300,248	„ 23	1,299,277	710	248	13	1,243,416	
1,300,248	„ 30	1,299,219	768	248	13	1,250,607	
1,300,248	Apr. 6	1,299,582	706	248	8	1,260,840	
1,300,248	„ 13	1,299,190	798	248	12	1,278,559	
1,300,248	„ 20	1,299,372	717	248	13	1,280,611	
1,300,248	„ 27	1,299,229	760	248	11	1,280,308	
1,300,248	May 4	1,299,366	623	248	11	1,278,804	
1,300,248	„ 11	1,299,280	708	248	11	1,276,097	
1,300,248	„ 18	1,299,312	677	248	11	1,273,551	
1,300,248	„ 25	1,299,284	705	248	10	1,267,907	
1,300,248	June 1	1,299,312	675	248	12	1,271,971	
1,300,248	„ 8	1,299,282	705	248	12	1,280,136	
1,300,248	„ 15	1,299,334	695	248	11	1,283,071	
1,300,248	„ 22	1,299,285	705	248	10	1,278,807	
1,300,248	„ 29	1,299,183	805	248	12	1,277,879	
1,350,248	July 6	1,349,285	704	248	11	1,284,593	
1,350,248	„ 13	1,349,203	787	248	10	1,288,798	
1,350,248	„ 20	1,349,251	736	248	13	1,296,682	
1,350,248	„ 27	1,349,186	801	248	13	1,305,124	
1,350,248	Aug. 3	1,349,244	742	248	14	1,307,468	
1,350,248	„ 10	1,349,217	771	248	12	1,302,773	
1,350,248	„ 17	1,349,286	701	248	13	1,290,998	
1,350,248	„ 24	1,349,287	702	248	11	1,280,179	
1,350,248	„ 31	1,349,286	702	248	12	1,274,950	
1,350,248	Sept. 7	1,349,312	678	248	10	1,272,500	
1,350,248	„ 14	1,349,278	714	248	8	1,262,681	
1,350,357	„ 21	1,349,245	742	357	12	1,267,549	
1,300,357	„ 28	1,299,323	667	357	10	1,264,487	
1,300,357	Oct. 5	1,299,295	694	357	10	1,264,455	
1,300,357	„ 12	1,299,243	747	357	10	1,261,835	
1,300,357	„ 19	1,299,287	700	357	13	1,259,508	
1,300,357	„ 26	1,299,296	694	357	10	1,258,726	
1,300,357	Nov. 2	1,299,194	794	357	12	1,260,048	
1,300,357	„ 9	1,299,332	655	357	13	1,260,353	
1,300,357	„ 16	1,299,294	694	357	11	1,259,901	
1,300,357	„ 23	1,299,300	689	357	11	1,260,200	
1,300,357	„ 30	1,299,309	679	357	12	1,265,842	
1,300,357	Dec. 7	1,299,381	608	357	11	1,283,685	
1,350,357	„ 14	1,349,339	652	357	9	1,312,062	
1,350,357	„ 21	1,349,280	704	357	16	1,318,220	
1,350,357	„ 28	1,349,254	733	357	12	1,321,928	

* At 172*s.* 3*d.* per fine oz.

† Coin other than Gold Coin.

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WEEKLY RETURN

for Wednesday in each Week, during the year 1949

(000's omitted)

9	10	11	12	13	14	15	16	17	18
BANKING DEPARTMENT									
Liabilities				Dates (Wednesdays)	Assets				Totals of Liabilities and Assets
Capital (£14,553) and Rest	Public Deposits	Bankers' Deposits	Other Deposits		Govt. Securities	Discounts and Advances	Other Securities	Reserve (Notes and Coin)	
£	£	£	£		£	£	£	£	£
18,170	30,991	308,661	93,169	Jan. 5	374,859	21,960	22,229	31,943	450,991
18,203	20,773	310,629	89,651	,, 12	342,934	20,801	22,419	53,102	439,256
18,244	21,433	341,026	90,948	,, 19	354,194	23,506	23,554	70,397	471,651
19,281	29,772	294,652	89,359	,, 26	299,574	26,001	26,542	79,947	432,064
18,323	17,756	298,763	90,116	Feb. 2	290,489	28,951	28,543	76,974	424,958
18,337	40,695	296,243	85,809	,, 9	310,539	28,520	28,085	73,940	441,084
18,380	28,978	299,518	38,670	,, 16	298,614	36,855	24,598	75,479	435,546
18,429	28,458	295,667	90,645	,, 23	301,689	32,124	23,408	75,978	433,199
18,472	26,192	306,431	92,522	Mar. 2	310,929	28,439	33,653	70,596	443,607
18,494	26,115	295,789	87,456	,, 9	317,614	23,664	22,942	63,734	427,854
18,515	34,862	295,608	86,942	,, 16	331,314	19,998	23,236	61,379	435,927
18,535	17,411	290,338	91,931	,, 23	312,879	24,487	23,490	60,359	418,215
18,550	32,326	294,028	90,109	,, 30	328,569	19,927	33,491	53,026	436,013
17,714	21,196	291,044	91,758	Apr. 6	337,389	18,336	22,604	43,383	421,712
17,745	29,100	290,021	91,949	,, 13	357,639	21,262	23,872	26,042	428,815
17,763	13,444	307,422	93,964	,, 20	370,664	16,278	21,606	24,045	432,593
17,816	17,473	289,939	91,952	,, 27	347,704	13,679	31,613	24,184	417,180
17,853	9,530	292,597	87,422	May 4	335,659	14,858	31,256	25,629	407,402
17,888	10,687	287,923	86,824	,, 11	330,144	18,819	26,037	28,322	403,312
17,922	26,739	202,526	88,344	,, 18	349,784	20,638	24,404	30,705	425,531
17,945	35,298	299,910	90,379	,, 25	357,644	25,858	23,753	36,277	443,532
18,001	43,630	287,583	89,209	June 1	358,464	24,473	23,154	32,332	438,423
18,038	37,816	287,429	85,913	,, 8	360,199	22,879	21,938	24,180	429,196
18,073	19,217	207,280	88,724	,, 15	357,264	22,062	22,730	21,238	433,294
18,212	21,363	302,315	87,214	,, 22	356,059	25,062	22,265	25,628	429,024
18,150	22,042	294,543	90,943	,, 29	338,924	26,962	33,113	26,679	425,678
15,180	30,514	291,919	90,386	July 6	316,624	22,736	21,559	70,080	430,999
18,221	34,468	289,300	89,004	,, 13	332,724	11,581	22,635	66,053	432,993
18,259	39,246	296,985	91,447	,, 20	345,779	18,406	23,489	58,263	445,937
18,300	43,595	294,012	90,961	,, 27	347,229	15,337	34,410	49,872	446,868
18,334	45,313	286,067	89,760	Aug. 3	349,754	13,048	29,068	47,604	439,474
18,364	42,556	288,725	87,474	,, 10	345,419	11,096	28,287	52,317	437,119
18,395	54,378	287,916	89,419	,, 17	349,274	10,654	25,999	64,181	450,108
18,435	54,835	291,744	89,746	,, 24	343,859	12,814	22,917	75,170	454,760
18,457	57,602	277,624	91,220	,, 31	320,619	10,353	33,517	80,414	444,903
18,473	19,657	284,513	92,205	Sept. 7	301,529	7,511	22,904	82,904	414,848
18,495	18,418	291,514	91,262	,, 14	303,609	6,493	23,764	85,823	419,689
18,514	36,944	293,659	96,105	,, 21	318,374	16,225	22,469	88,154	445,222
18,531	25,439	295,696	93,942	,, 28	333,819	23,565	34,864	41,360	433,608
17,705	27,825	291,568	91,939	Oct. 5	339,529	25,452	22,667	41,389	429,037
17,733	58,081	301,061	97,535	,, 12	380,379	26,582	23,423	44,026	474,410
17,754	63,454	306,962	96,669	,, 19	394,214	20,215	24,015	46,395	484,839
17,783	76,815	298,456	107,273	,, 26	402,709	23,282	27,031	47,285	500,327
17,844	64,772	293,081	114,767	Nov. 2	394,094	21,481	28,855	46,034	490,464
17,877	63,666	299,690	115,099	,, 9	406,534	15,890	28,186	45,722	496,332
17,912	68,058	306,302	112,530	,, 16	420,339	12,123	26,267	46,072	504,802
17,944	69,555	300,580	112,163	,, 23	415,559	15,614	23,429	45,640	500,242
17,980	67,562	295,899	111,544	,, 30	403,819	15,283	34,016	39,867	492,985
18,011	90,097	308,930	110,980	Dec. 7	467,069	15,166	23,875	21,908	528,018
1,8058	90,191	295,402	111,668	,, 14	430,504	16,241	24,917	43,657	515,319
18,091	112,124	296,490	113,401	,, 21	458,499	19,546	24,598	37,463	540,106
18,132	109,580	299,194	111,178	,, 28	468,359	14,751	21,261	33,713	538,084

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REVENUE OF THE UNITED KINGDOM

Net Produce in Quarters of 1949, *and the Financial Years ended March* 31, 1948–49, 1947–48, 1946–47, 1945–46

(000's omitted)

Quarters ended	March 31, 1949	June 30, 1949	Sept. 30, 1949	Dec. 31, 1949	Total for Calendar Year 1949
	£	£	£	£	£
Inland Revenue—					
Income tax	809,282	137,578	206,906	169,534	1,323,300
Surtax	61,950	19,000	12,300	10,400	106,650
Death duties	45,291	31,600	48,300	51,100	176,291
Stamps	14,070	9,700	12,100	14,100	49,970
Profits tax	59,150	34,100	84,600	66,400	244,250
Excess profits tax	10,300	14,300	7,300	8,400	40,300
Other Inland Revenue duties	570	60	10	..	640
Special contribution	47,100	6,600	4,900	3,700	62,300
Total Inland Revenue	1,047,713	252,938	376,416	326,634	2,003,701
Customs	198,403	146,730	196,139	213,737	755,009
Excise	181,700	122,620	189,000	181,700	675,020
Total Customs and Excise	380,103	269,350	385,139	395,437	1,430,029
Motor vehicle duties	39,990	4,883	4,204	3,417	52,494
Sale of surplus war stores	8,311	26,307	20,115	19,198	73,931
Surplus receipts from certain trading services	23,738	4,045	10,000	28,946	66,729
Post Office (net receipts)	451	2,600	..	..	3,051
Broadcast receiving licences	3,945	1,690	2,350	3,600	11,585
Crown lands	200	130	150	240	720
Receipts from sundry loans	6,339	1,909	8,137	1,947	18,332
Miscellaneous receipts	67,126	15,581	14,185	31,574	128,466
Total Ordinary Revenue	1,577,916	579,433	820,696	810,993	3,789,038
Self-balancing Revenue—					
Post Office	39,449	37,250	39,550	42,700	150,949
Income tax, deducted from excess profits tax, post-war refunds	2,230	1,785	3,329	4,270	11,614

Years ended March 31	1948–49	1947–48	1948–49 (compared with 1947–48)		Corresponding Years	
			Increase	Decrease	1946–47	1945–46
Inland Revenue—						
Income tax	1,367,570	1,189,728	177,842	..	1,156,233	1,361,346
Surtax	97,900	91,220	6,680	..	75,742	69,069
Death duties	177,141	172,029	5,112	..	148,044	120,301
Stamps	56,433	56,280	153	..	38,338	25,099
Profits tax	199,090	36,120	162,970	..	..	..
Excess profits tax	79,805	252,568	..	172,763	325,391	430,877
Other Inland Revenue duties	700	715	..	15	724	712
Special contribution	79,450	..	79,450	..	..	..
National defence contribution	..	..	..	..	32,107	35,485
Total Inland Revenue	2,058,089	1,798,660	432,207	..	1,776,579	2,042,889
Customs	823,258	791,101	32,157	..	620,741	569,842
Excise	733,500	629,700	103,800	..	563,500	540,800
Total Customs and Excise	1,556,758	1,420,801	135,957	..	1,184,241	1,110,642
Motor vehicle duties	52,716	49,108	3,608	..	49,456	43,172
Sale of surplus war stores	99,597	197,231	..	97,634	155,996	..
Surplus receipts from sundry trading services	28,564	101,261	..	72,697	59,000	..
Post Office (net receipts)	..	..	..	..	..	..
Broadcast receiving licences	11,700	11,200	500	..	9,940	5,180
Crown lands	860	950	..	90	920	960
Receipts from sundry loans	17,683	23,044	..	5,361	26,779	11,047
Miscellaneous receipts	180,623	242,603	..	61,980	78,312	70,560
Total Ordinary Revenue	4,006,590	3,844,859	572,272	410,540	3,341,223	3,284,450
			Net Incr. £161,732			
Self-balancing Revenue—						
Post Office	152,700	143,300	..	..	131,000	115,500
Income tax deducted from excess profits tax, post-war refunds	81,751	83,183	..	..	150,522	1,253

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Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART II, 1950.

A Statistical Demand Function for Food in the U.S.A.

By James Tobin*

[Read before the Royal Statistical Society, January 20th, 1950, Mr. H. Campion, C.B., Vice-President, in the Chair.]

Quantitative data relating to the demand for consumers' goods and services are, for the most part, of two very different kinds, time series and family budget surveys. Time series are generally aggregate data: observations in successive periods of the total national consumption of a commodity and of possible explanatory variables, principally national income and prices. A family budget survey is a set of observations, for a single time period, of the expenditures on the goods by families who differ in income, size and other characteristics. The premise of this paper is that a statistical demand function should be consistent with both kinds of observations.

Most statistical analysis of consumer behaviour has relied exclusively on one or the other of the two types of data.† The relationship of national consumption to other national aggregates has been found from time series, without investigation of the consistency of this aggregate demand function with the evidence concerning family behaviour. Or budget data have been analysed to determine the effects of family income and other variables on family expenditures, without considering the consistency of the estimates of these effects with time series of aggregate variables.

There are both economic and statistical reasons for basing quantitative demand analysis on a combination of time series and budget data. The economic reason is the obvious fact that aggregate consumption and income are the sums of the consumptions and incomes of families.‡ Any relationship among these and other aggregates is the reflection of a multitude of family consumption decisions. A hypothesis concerning the determination of aggregate demand should be derived from a hypothesis about family expenditure. The connection between the family demand function and its aggregate counterpart will, in general, involve the joint distribution of families by income and by the other variables in the family demand function.§

Statistically, widening the scope of the observations on which statistical demand analysis is based increases the possibility of rejecting hypotheses and improves the estimates of the parameters of demand functions (Marschak, 1939*b*, p. 487, and 1943, p. 42). The increase in statistical power is due not merely to the addition of new information, but to the addition of information of a different nature. Economic time series are notoriously poor material for choosing

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† Two exceptions, to which the approach of the present paper owes much, should be noted: Marschak (1943) and Staehle (1945).

‡ For convenience, a single individual will be considered a "family" of one person.

§ The theoretical connection between the family demand function and the aggregate demand function, via the distribution of families by income, has been considered by Marschak (1939*a*), Staehle (1937) and de Wolff (1941). A more general treatment is given by Haavelmo (1947).

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among hypotheses; and simply extending the length of their span does not eliminate the difficulty. The estimation of parameters from time series encounters many statistical pitfalls, which need not be rehearsed here (Stone, 1948). These difficulties are mitigated if it is possible on the basis of other information to restrict the field of acceptable hypotheses and the range of possible parameter values.

Budget studies provide observations in which the persistent correlations of some explanatory variables over time are broken; indeed, they constitute an experiment in which certain relevant variables, such as prices, are constant while others, chiefly income, vary. Moreover, micro-economic data escape some of the difficulties of identification to which aggregate time series are subject. For example, an observation of aggregate demand is also an observation of total supply, and the observed relationship of total consumption to other macro-economic variables may reflect the operation of a supply function as well as a demand function. But the observed consumption of a family is unambiguously a point on its demand function, since a single family could have bought more or less of the commodity without affecting its price. For these reasons, the use of budget data may help to rescue statistical demand analysis from the traps encountered in relying exclusively on time series. But for the same reasons, budget statistics are by themselves insufficient to test a complete hypothesis concerning demand or to estimate all the parameters of a demand function, at least until surveys made at different times are much more numerous than at present. Some of the relevant variables change only with time, and their effects cannot be evaluated without appeal to time series of aggregates.

This paper is an attempt to derive two related statistical demand functions for food for the United States, one the family demand function and the other the aggregate demand function, by combining information from budget surveys and from time series. "Food" is treated as a single commodity, and variations over time in the quantity and price of this commodity are measured by index numbers. The variables determining family food demand are assumed to be disposable family income in the current and preceding years, family size, the food price index and the index of prices of other consumers' goods. The form of the function assumed implies that the elasticity of demand with respect to each of these variables is constant. In section 1 the elasticities of family food expenditure with respect to family income and size, with prices constant, are estimated from budget data. The estimate of income-elasticity is interpreted as the sum of the elasticity with respect to current income and the elasticity with respect to income of the previous year. This interpretation is justified by the evidence for a lag in adjustment of food expenditure to changes in income and by the high correlation of family incomes in two successive years. In section 2 the aggregate demand function is derived from the family function. Under certain realistic assumptions concerning the distribution of families by income and size, it is shown that the aggregate function has the same form and the same elasticities as the family function. Given the estimate of the sum of the two income-elasticities obtained in Section 1, the parameters of the two demand functions are estimated in Section 3 by multiple correlation of time series of aggregates. Section 4 examines the relationships between food expenditure and family income in budget surveys made at different times to see if the differences among these relationships can, with the parameter estimates obtained in Section 3, be attributed to differences in prices and lagged income.

1. *The Family Food Demand Function*

1.1. *The Form of the Function*

The family food demand function is assumed to be:

$$c_t = k y_t^{\alpha_1} y_{t-1}^{\alpha_2} P_t^{\beta} Q_t^{\gamma} n_t^{\delta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where

c_t = quantity of food consumed by a family in year t, whether purchased, received in kind, or home-produced.

y_t = disposable family income for year t: money income plus income in kind, including gifts in money or in kind from other families, less direct taxes and gifts to other families.

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P_t = index of food prices, average for year t.
Q_t = index of prices of other consumers' goods, average for year t.
n_t = number of persons in the family in year t, counting a person in the family for a fraction of the year as the same fraction of a full person.
α_1 = elasticity of food demand with respect to current income.
α_2 = elasticity of food demand with respect to previous year's income.
β = elasticity of food demand with respect to food price index.
γ = elasticity of food demand with respect to non-food price index.
δ = elasticity of food demand with respect to family size.

k is a constant which depends on the units in which the variables are measured. (In general, lower-case letters indicate micro-economic variables, and capital letters macro-economic variables. Greek letters are used for the elasticities.)

Function (1) is chosen in preference to a linear relationship for a combination of reasons: (*a*) The relationship between family income and food expenditure in budget data is obviously not linear; as would be expected on *a priori* grounds, the marginal propensity to consume food decreases with income. A linear relationship between the logarithms gives a good fit to the data without requiring additional parameters. (*b*) This form of the family demand function implies, under certain simple and plausible aggregation assumptions, an aggregate relationship of the same functional form with the same elasticities. (See Section 2.) (*c*) Consistency of consumer behaviour requires that the sum of the elasticities of demand with respect to variables of a monetary dimension be identically zero. This theoretical proposition is, of course, not a licence to impose the zero-sum restriction on statistical estimates of elasticities. But it is a reason for adopting a form for statistical demand functions which permits but does not enforce results conforming with the "homogeneity postulate." Function (1) has this property: if y_t, y_{t-1}, P_t and Q_t exhaust the variables of monetary dimension relevant to food demand, then the "homogeneity postulate" implies:

$$\alpha_1 + \alpha_2 + \beta + \gamma = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

A linear function in the same variables does not have this property unless it goes through the origin. It is true that the use of functions of the form of (1) for more than one commodity is inconsistent with another requirement of the theory of consumer choice, namely the Slutsky condition on cross-elasticities. Moreover, such a function could not be used for every consumer's good, including saving, without violating the identity of the sum of expenditures and income. But the present investigation concerns only one commodity (Stone, 1945, pp. 293–294.)

1.2. *The Effect of Previous Year's Income*

Information from budget surveys can provide only two of the five equations required to evaluate all the exponents in (1). The remaining equations must be determined by time series correlation of aggregate data. Budget data can yield, under certain assumptions to be set forth in this section, an estimate of the sum $\alpha_1 + \alpha_2$, which will be called α, and of δ.

Since the observations reported in a budget study refer to a common time period, P_t and Q_t are constant over all families. Consequently (1) becomes

$$c_t = k'_t\, y_t^{\alpha_1}\, y_{t-1}^{\alpha_2}\, n^{\delta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where $k'_t = kP_t^{\beta}\, Q_t^{\gamma}$ is constant over all families in year t.

If a budget study classified families according to their previous year's income, current income and size, the three elasticities α_1, α_2 and δ could be estimated directly from budget data. In the absence of data concerning lagged income, none of the three exponents can be estimated without assuming either an equation involving the parameters or a relationship between y_t and y_{t-1}.

The usual procedure is to assume $\alpha_2 = 0$, i.e. that there is no lag in the adjustment of consumption to income. Then α_1 can be evaluated from budget data by regression of consumption on current income, taking account of family size.

However, the adjustment of consumption, even food consumption, to family income is in fact not instantaneous. The hypothesis of a lag in the relationship of food demand to income is supported not only by common sense but by the evidence of budget data. The 1941–42 survey

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for the United States shows food expenditures in the first quarter of 1942 separately for two classes of urban families, those whose annual rates of income were lower than in 1941 by 5 per cent. or more, and those whose incomes were higher than in 1941 by 5 per cent. or more. Fig. 1 shows the average food expenditure at eight 1942 income levels for these two groups of families, and for the sample as a whole (including families who experienced less than 5 per cent. change in income).* The comparison is strong evidence of a lag in adjustment of food expenditure to income level. For each of the eight current income-classes of families, average expenditure is higher for those who suffered a fall in income than for those who experienced a rise. These data do not permit the evaluation of α_2, but they indicate that it is significantly bigger than zero.† Moreover, current family income is certainly highly correlated with previous year's income. Table 1 shows the distribution of families of six 1941 income classes by 1942 income. Average income in the first quarter of 1941 was at an annual rate 7 per cent. higher than 1941 average income, and Table 1 therefore shows that more families moved to higher brackets than to lower.

TABLE 1

Percentage Distribution of 1942 *Money Incomes for City Families of Six* 1941 *Income Classes*

1941 *Money Income* (*Dollars*)	1942 *Money Income* (*Dollars, Annual Rate Based on First Quarter*)					
	0–500	500–1,000	1,000–1,500	1,500–2,000	2,000–3,000	Over 3,000
0–500	78	16	5	..	1	..
500–1,000	9	66	18	5	2	..
1,000–1,500	2	10	52	27	8	1
1,500–2,000	1	1	11	50	35	2
2,000–3,000	..	1	2	7	63	27
Over 3,000	..	..	..	..	13	85

Source: B.L.S. (1942), Table 4, p. 423, and Table 6, p. 424.

The correlation between the two years' incomes means that the regression coefficient of family consumption on current income reflects the effect of past income as well. Neglect of the lag results in an over-estimate of α_1 as well as an under-estimate of α_2. The customary assumption that $\alpha_2 = 0$ must be replaced by an alternative assumption which recognizes the importance of past income and its correlation with current income.

Assume, therefore, that the geometric average previous year's income $\bar{y}_{t-1}$ of an income class of families of given size with current income $\bar{y}_t$ is given by

$$\bar{y}_{t-1} = \frac{Y_{t-1}}{Y_t}\bar{y}_t \qquad (4)$$

where Y_t is average disposable income per family in year t.‡ Every group of families, classified

* U.S. Bureau of Labor Statistics (hereafter referred to as B.L.S.), 1945. The sources of the data on which Fig. 1 is based are as follows: Table 11, p. 38, gives food consumption by 1942 income classes for families with changed incomes. Table 20, p. 107, gives this information for the whole sample. Only money income and money expense for food are considered. Families of all sizes are included; the data of Table 11 do not permit elimination of the effects of family size. Since Table 11 does not give average incomes for the various income classes, the average disposable incomes for the whole sample have been used in plotting all three sets of observations in Fig. 1. These are computed from Table 19, p. 103, by subtracting "Personal tax payments" from "Money income."

† Convincing evidence that income change is an important variable not only for food but for other consumption categories and for saving is given by Mack (1948). This evidence is based not only on the 1941–42 budget survey, but on continuing samples of farm families, whose behaviour under rising incomes is summarized in Cochrane (1947).

‡ Since $\bar{y}_{t-1}$, $\bar{y}_t$ are geometric means and Y_{t-1}, Y_t are arithmetic means the question arises whether $\bar{y}_{t-1} = K\bar{y}_t$, summed over all groups of families, implies $Y_{t-1} = KY_t$. This is not in general true, but it is true under the assumption (13) concerning the joint distribution of families by income and size which will be introduced in section 2 below.

Let $\overline{Y}_{t-1}$ and $\overline{Y}_t$ be the geometric means in the two years. Clearly $\bar{y}_{t-1} = K\bar{y}_t$ implies $\overline{Y}_{t-1} = K\overline{Y}_t$. Assumption (13) is that for all $\lambda > 0$, $\lambda f(\lambda y, n;\ \lambda Y) = f(y, n;\ Y)$ where $f(y, n;\ Y)$ is the density function of the joint distribution when mean income is Y.

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by current income, is assumed to have undergone the same relative change in income; it is not required that each individual family experience the same change. From (3) it follows that the geometric average consumption $\bar{c}_t$ of a group of families of size n with geometric average incomes $\bar{y}_t$ and $\bar{y}_{t-1}$ is given by

$$\bar{c}_t = k'_t \bar{y}_t^{\alpha_1} \bar{y}_{t-1}^{\alpha_2} n^{\delta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Substituting (4) in (5),

$$\bar{c}_t = k''_t \bar{y}_t^{\alpha} n^{\delta} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where $\alpha = \alpha_1 + \alpha_2$

$$k''_t = \left(\frac{Y_{t-1}}{Y_t}\right)^{\alpha_2} k'_t = k\left(\frac{Y_{t-1}}{Y_t}\right)^{\alpha_2} P_t^{\beta} Q_t^{\gamma}$$

is constant over all income-size groups of families.

This method of allowing for the influence of lagged income is compelled by the inadequacy of data concerning the quantitative effect of past income on food consumption and concerning the joint distribution of families by incomes in two successive years. Table 1 indicates that assumption (4) is not far wide of the mark. There is some evidence (Mack, 1948) that assumption (4) errs by attributing too low a lagged income to families of low current income and too high a lagged income to families of high current income.* If this is true, the use of assumption (4) will give too low an estimate of α; more of the observed consumption of low-income families and less of that of high-income families will be due to past income than assumed in (6). In Fig. 1 this bias should be revealed in a flatter slope for the whole sample than for the two groups classified by direction of income change. Fig. 1 does not show serious bias of this kind.

1.3. *The Family Demand Function Estimated from* 1941 *Budget Data*

The parameters of function (6) can now be estimated from budget data. In terms of the logarithms of the variables (6) becomes

$$\log \bar{c}_t = \log k''_t + \alpha \log \bar{y}_t + \delta \log n \quad . \quad . \quad . \quad . \quad . \quad (7)$$

In fitting (7) to budget data, a difficulty arises because of the manner in which the basic observations are summarized for publication. Observations of $(\bar{c}, \bar{y}, n)$ are not presented. The reported observations are arithmetic rather than geometric means for consumption and income. The arithmetic means will not be far from function (6) except for income-classes within which the function diverges markedly from a straight line. Clearly the reported averages for the open-ended upper income-classes in budget studies should not be used in fitting non-linear demand functions. In the present case inclusion of these observations would seriously over-estimate income-elasticity. For other income-classes, the reported arithmetic means have been treated as observations of $(\bar{c}, \bar{y}, n)$.

$$\log \bar{Y}_{t-1} = \int_0^{\infty} \log y \, f(y, n; Y_{t-1}) dy = \log K + \int_0^{\infty} \log y \, f(y, n; Y_t) dy = \log K \bar{Y}_t.$$

Let $Y_{t-1} = K' Y_t$. Then, using assumption (13),

$$\log \bar{Y}_{t-1} = \int_0^{\infty} \log K' y \, f(K' y, n; K' Y) K' dy = \int_0^{\infty} \log K' y \, f(y, n; Y_t) \, dy$$

$$= \log K' \int_0^{\infty} f(y, n; Y_t) \, dy + \int_0^{\infty} \log y \, f(y, n; Y_t) \, dy$$

$$= \log K' Y_t.$$

Therefore $K = K'$.

* Mrs. Mack's contention is based on the distributions of income-change by income level in the 1941–42 budget survey and in the Wisconsin sample of identical taxpayers, 1929–35. However, her 1941–42 data give only direction of income change, not magnitude. The Wisconsin figures cited by Mrs. Mack detect a change in income only when a taxpayer moves from one $500-wide bracket to another, and are confined to incomes below $3,000. No quantitative relationship between income and income change can be formulated from these sources. Moreover, Mrs. Mack also cites a study of Delaware taxpayers for two years, 1937 and 1938, which evidently conforms more closely to assumption (4) than to the pattern of the other two samples.

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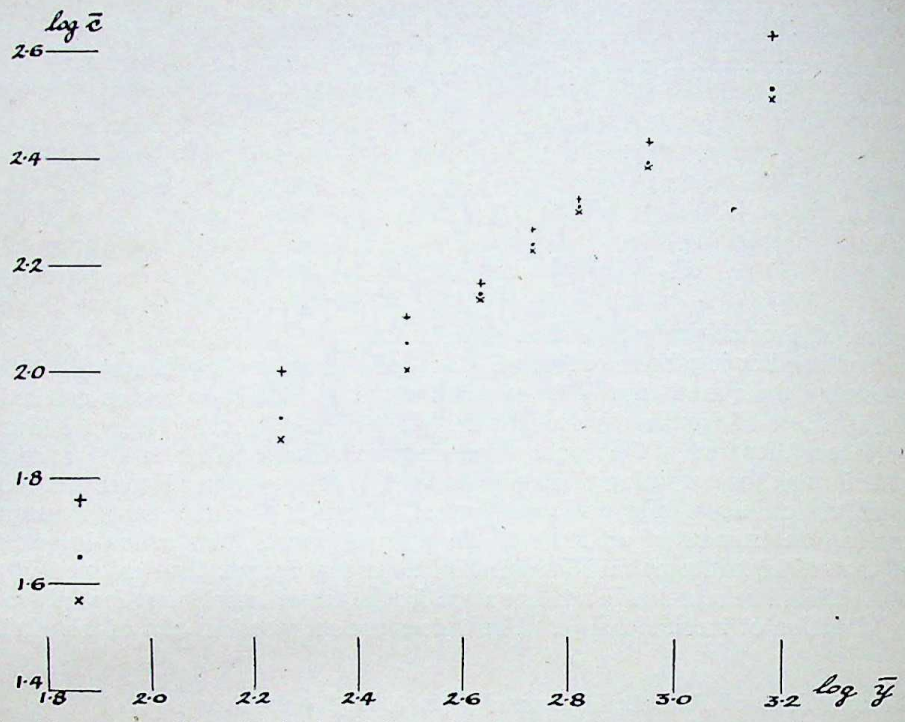

FIG. 1.—Money expenditure for food and disposable income, all urban families, first quarter, 1942
● All families.
× Families with incomes 5 per cent. or more higher than 1941.
+ Families with incomes 5 per cent. or more lower than 1941.

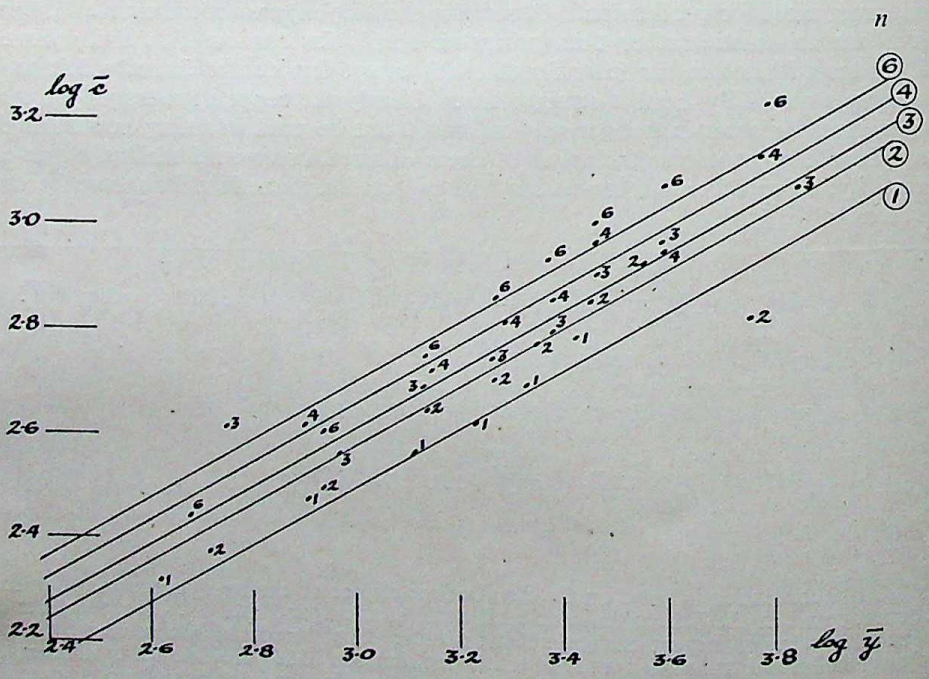

FIG. 2.—Family income and food expenditure for various sizes of family, 1941.
Budget study observations ● n.
Regression $\log \bar{c} = \cdot 82 + \cdot 56 \log \bar{y} + \cdot 25 \log n$.

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With this qualification, the 1941 urban budget study (B.L.S., 1945) provides observations of $(\bar{c}, \bar{y}, n)$ for $n = 1, 2, 3, 4$. Observations for $n \geqq 5$ are also reported, and it is possible to compute for each income-class the average size of families of five or more. It is assumed that the variances of n about these averages are so small that no significant error is introduced by assuming that all the large ($n \geqq 5$) families in each income-class are of the average size of large families in that class. With this assumption, there are 37 observations $(\bar{c}, \bar{y}, n)$. These are shown in Table 2.

These data yield the following regression of $\log \bar{c}$ on $\log \bar{y}$ and $\log n$:

$$\log \bar{c} = \cdot 82 + \cdot 56\ (\pm \cdot 03) \log \bar{y} + \cdot 25\ (\pm \cdot 07) \log n \quad . \quad . \quad . \quad (8)$$
$$R^2 = \cdot 93$$

In figure 2 function (6) with constants based on regression (8) is plotted on income and consumption axes, separately for $n = 1, 2, 3, 4, 6$. The observations on which the regression is based are also shown, each tagged with the value of n for the observation. (The points labelled "6" refer to families of five or more persons.)

The values computed for α and δ confirm a fact noted in previous analyses of budget data and known to every housewife, the economies of large family food consumption. Since the sum of α and δ is less than one, a doubling of both income and family size would not double food consumption. At the same *per capita* income, *per capita* food expenditure is smaller the larger the size of the family. This is, of course, partly due to lower consumption by children. But it may also be explained partly by indivisibilities in kitchen inputs and partly by external economies. Recipes which require one egg and serve four persons are not available to the woman who is cooking for two. The bargains obtained by purchasing large quantities do not help the small family which cannot use up a large can before it either spoils or crowds the refrigerator.

TABLE 2

Observations of Average Food Consumption, $\bar{c}$, *Average Disposable Income,* $\bar{y}$, *and Family Size,* n, *for* 37 *Groups of Urban Families Classified by Income and Size,* 1941.

$\bar{y}$ (*dollars*)	$\bar{c}$ (*dollars*)	n (*number*)	$\bar{y}$ (*dollars*)	$\bar{c}$ (*dollars*)	n (*number*)
421	210	1	2,872	770	3
824	301	1	3,864	934	3
1,287	369	1	6,925	1,198	3
1,703	433	1	799	419	4
2,150	506	1	1,401	531	4
2,655	621	1	1,939	658	4
520	239	2	2,414	725	4
869	319	2	2,878	935	4
1,379	454	2	3,895	907	4
1,846	517	2	5,983	1,349	4
2,262	600	2	484	279	6·4
2,855	723	2	873	409	6·4
3,611	849	2	1,364	569	6·2
5,593	673	2	1,849	732	6·1
456	417	3	2,345	866	5·8
936	368	3	2,891	1,020	5·8
1,357	499	3	3,936	1,197	6·3
1,837	562	3	6,056	1,708	6·3
2,408	629	3			

Source: (B.L.S., 1945):—

Disposable income, $\bar{y}$: for each size category.

"Average amount of income: Total" (Table 18, pp. 96–100).

– "Personal tax payments" (Table 19, pp. 102–105).

– ½ "Gifts and contributions" (Table 19, pp. 102–105).

The last item is subtracted in order to avoid counting twice those transfers in money or in kind which are included in the income of the recipient. Not all of the amount reported under the heading "gifts and contributions" is of this nature. Support of religious and educational institutions and community enterprises are properly consumption expenditures which create income rather than transfers. Not all gifts in kind from other families were reported in the income and consumption of the recipient; only gifts in

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the major categories of consumption were so treated (p. 17). Accordingly not all gifts in kind should be excluded from the income and consumption of the donors. Averages for seven kinds of "gifts and contributions" are presented only for large groups of families, not for the income-size-classes considered here. The fraction $\frac{1}{2}$ is a guess of the proper amount to subtract, based on a rough division of the average amount of "gifts and contributions" for all urban families (Table 12, p. 87) between transfers and consumption.

Food consumption $\bar{c}$: for each size category.
"Food: Total" (Table 20, pp. 111–119).

Family size n:
The last eight entries in this column are estimates of the average size of families of 5 or more. Table 1A, p. 69, gives for each of six income-classes the number of families of each size from 1 to 6, and the number of size 7 or larger. Table 1, p. 68, gives the total number of urban families of all sizes in each income-class, and Table 2, p. 70, gives the average size of families in each income-class. The total number of persons in families of 5 or more and the total number of such families can therefore be computed for each income-class.

1.4. *The Evidence of Other Budget Studies*

The 1941 urban budget study has been used, in preference to other surveys of national scope, to derive the income-elasticity of family food demand for two reasons. The concepts of income and food consumption used in the 1941 urban sample are the most inclusive, and this study permits the most satisfactory allowance for family size, which on *a priori* grounds would be expected to be the most important variable other than income.

The estimate of income-elasticity derived from 1941 urban data will be applied in section 3 to time series observations for the whole economy. Is the estimate applicable to the rural part of the population? Is the estimate applicable to years other than 1941? The present section endeavours both to check the estimate against the evidence of urban budget surveys made in other years and to see whether rural families have the same income-elasticity of demand as urban families.

Unfortunately, for the same reasons that the 1941 urban study is superior to others, it is impossible to duplicate the calculation of income-elasticity in (8) for other years. Comparisons can usually be made only by limiting the 1941 data to the concepts of income and food consumption used in the other studies. Also, a less precise adjustment for the effects of family size must be made. It is then possible to examine the consistency of the income-consumption relationships in various budget studies, but not to check the exact magnitude of the income-elasticity obtained in (8).

1.4.1

The other urban budget studies of national scope with which the 1941 results should be compared are the 1918 survey of urban workers with families of 4 or more (B.L.S., 1924) and the all-inclusive survey of 1935–36 (U.S. National Resources Committee, 1939 and 1941). Two less extensive studies made in 1927–28 provide material for another inter-temporal comparison of income-food consumption relationships.* One of these concerns federal employees in five cities; the other covers railroad maintenance-of-way employees in ten states. The samples are considerably smaller than those of the three national surveys, and they are samples of two special groups. Moreover, it is necessary to splice the two studies together in order to cover a wide income range. For these reasons, the relationship between income and food consumption obtained from 1927–28 data is less reliable than those derived from the other studies. Finally, the only post-war budget data available refer to families in three cities, Richmond, Va., Washington, D.C., and Manchester, N.H., for the year 1947 (B.L.S., 1949). Since prediction is the ultimate objective of quantitative economics, comparison of pre-war and post-war budget data has a special interest which justifies using these limited data. In addition, samples of two kinds of rural families, farm and non-farm, are available for 1941 (U.S. Department of Agriculture, 1943) and for 1935–36 (U.S. National Resources Committee, 1941). These studies permit an examination of the difference between rural and urban consumption behaviour as well as additional checks of the consistency of income-elasticity over time.

* The data for the 1927–28 studies are given in Leven *et al.* (1934), Appendix B, Table 1, pp. 246–249, designations D and E. The original sources and the coverage and concepts of the two studies are described on p. 241.

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1.4.1.1

These other studies do not present data classified according to family size. Instead of observations of $(\bar{c}, \bar{y}, n)$, like those of the 1941 urban study, they report only observations of $(\bar{c}, \bar{y}, \bar{n}(\bar{y}))$ where $\bar{n}(\bar{y})$ is the average size of families in a given income class, with mean income $\bar{y}$.* To eliminate the effects of differences in family size on the comparison of one budget sample with another, observations of this kind must be adjusted to a common value of $\bar{n}$. The adjustment must not require information on the distribution of family sizes about the means $\bar{n}(\bar{y})$.

The approximate adjustment here employed assumes that the 1941 urban relationship between family size and food consumption applies to the other samples. The term n^{δ} in (6) is replaced by a linear expression in n:

$$\bar{c} = k''_{\iota}\, \bar{y}^{\alpha}\, (a + bn) \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Therefore the average consumption of families of all sizes in a given income class is given by

$$\bar{c} = k''_{\iota}\, \bar{y}^{\alpha}\, (a + b\bar{n}(\bar{y})) \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

An actual observation $(\bar{c}, \bar{y}, \bar{n}\ (\bar{y}))$ is adjusted to a hypothetical observation $(\bar{c}', \bar{y}, \bar{n}')$ for the same income but for a standard size $\bar{n}'$ by

$$\bar{c}' = \bar{c}\left(\frac{a + b\bar{n}'}{a + b\bar{n}}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

This adjustment assumes nothing concerning the value of α.

In practice the comparisons between budget studies concern only families of two or more families. For $2 \leq n \leq 7$, $n^{\cdot 25}$ can be approximated linearly by $1{\cdot}032 + {\cdot}092\, n$.

1.4.1.2

The differences among the budget studies with respect to definitions of income and food consumption are set forth in Table 3. Three types of information are distinguished; to each type correspond two definitions, one of income and the other of food expenditure. The table lists budget surveys which can be compared on the basis of information of each type.

TABLE 3

Definitions of Disposable Income and Food Consumption in Various Budget Data

Type	*Definition of disposable income*	*Definition of food consumption*	*Budget data available for comparison*
I	Disposable money income + Rent imputed to owner-occupiers + Other income in kind, including food	Money expenditure + Value received in kind (compensation, gifts, relief, home-grown)	Rural non-farm families, 1935–36 and 1941 Farm families, 1935–36 and 1941
II	Disposable money income + Imputed rent	Money expenditure	Urban families, 1927–28, 1935–36 and 1941
III	Disposable money income	,, ,,	Urban families, 1918, 1941 and 1947

* The 1935–36 study does classify data by family size, but not in a manner useful for the purposes of this paper. Families are classified by seven "types," which depend on age composition as well as size. Only in the cases of one- and two-person families is there one-to-one correspondence between "type" and size. Moreover, detailed breakdown of the observations by "type" appears only in publications dealing with specific localities or regions. On the treatment of family size in the 1935–36 survey, see Staehle (1945), pp. 249–251.

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1.4.1.3

The observations reported in all the studies were adjusted to an average family size of 3·5 by the method outlined in section 1.4.1.1. For each sample a line was then fitted by least squares to the logarithms of the observations of disposable income and food consumption. The slope of this line is an estimate of the income-elasticity of food demand. The estimates from those samples which use the same type of information can then be compared to check the consistency of the family income-elasticity over time. Only for information of Type I is there any reason to expect the estimates of income-elasticity to agree with the estimate of ·56 obtained in regression (8). The other types of information exclude food received in kind; since this is most important, relative to money expenditures, for low-income families, its omission should result in a higher estimate of income-elasticity.

Table 4 reports the regressions between the logarithms of food consumption and family income for each of the samples listed in Table 3. The regressions, together with the adjusted observations on which they are based, are shown in Figs. 3–6.

TABLE 4

Relationships of Food Consumption, Adjusted to Family Size 3·5, *to Disposable Income in Various Budget Data for Families of Two or More Persons*

	Type of information	*Budget sample*	*Regression* $\log \bar{c} =$
1.	I	Rural non-farm, 1935–36	$\cdot 92 + \cdot 55 \log \bar{y}$
2.	I	Rural non-farm, 1941	$1 \cdot 02 + \cdot 53 \log \bar{y}$
3.	I	Farm, 1935–36	$1 \cdot 16 + \cdot 37 \log \bar{y}$
4.	I	Farm, 1941	$1 \cdot 15 + \cdot 35 \log \bar{y}$
5.	II	Urban, 1927–28	$\cdot 57 + \cdot 68 \log \bar{y}$
6.	II	Urban, 1935–36	$\cdot 76 + \cdot 61 \log \bar{y}$
7.	II	Urban, 1941	$\cdot 64 + \cdot 65 \log \bar{y}$
8.	III	Urban, 1918	$\cdot 89 + \cdot 57 \log \bar{y}$
9.	III	Urban, 1941	$\cdot 68 + \cdot 64 \log \bar{y}$
10.	III	Richmond, Va., 1947	$\cdot 81 + \cdot 64 \log \bar{y}$
11.	III	Washington, D.C., 1947	$\cdot 96 + \cdot 59 \log \bar{y}$
12.	III	Manchester, N.H., 1947	$1 + \cdot 59 \log \bar{y}$

Sources of data on which the regressions were calculated:

1. U.S. National Resources Committee (hereafter, N.R.C.) (1941), Table 161, p. 56.

2. and 4. U.S. Department of Agriculture (hereafter, U.S.D.A.) (1943), Table 49, pp. 156–7, and Table 50, pp. 159–160.

3. N.R.C. (1941), Table 144, p. 51.

5. Leven *et al.* (1934), Appendix B, Table 1, pp. 246–249, lines D and E.

6. N.R.C. (1941), Table 178, p. 61.

7 and 9. B.L.S. (1945), Table 19, p. 102, and Table 20, p. 109.

8. B.L.S. (1924), Table 1, p. 4. This study does not report tax payments. However, in 1918, families of the large size to which the sample was confined had such small direct tax liabilities that it is safe to take money income before taxes as a measure of disposable money income.

10, 11, and 12. B.L.S. (1949).

In regressions 6 and 7, the observations for the lowest-income class of each sample were omitted. If they are included the slopes are, respectively, ·57 and ·69; the erratic nature of the lowest-income observations in the two years can be seen in Fig. 5. The explanation, and the justification for their omission, is that the exclusion of food received in kind affects the 1935–36 and 1941 samples unequally. The 1935–36 sample does not include recipients of relief; the 1941 sample does. Relief recipients rely much more on food received in kind than non-relief families of the same income. Consequently the 1935–36 low-income group shows higher money expenditures for food than the 1941 sample, and in both years the low-income point is out of line with the other observations.

The significance of the difference between two estimates of the coefficient of $\log \bar{y}$ can be tested for each pair of regressions based on the same type of information (Fisher, 1946, pp. 140–2.) With only one exception, a difference as large as observed would occur in over 10

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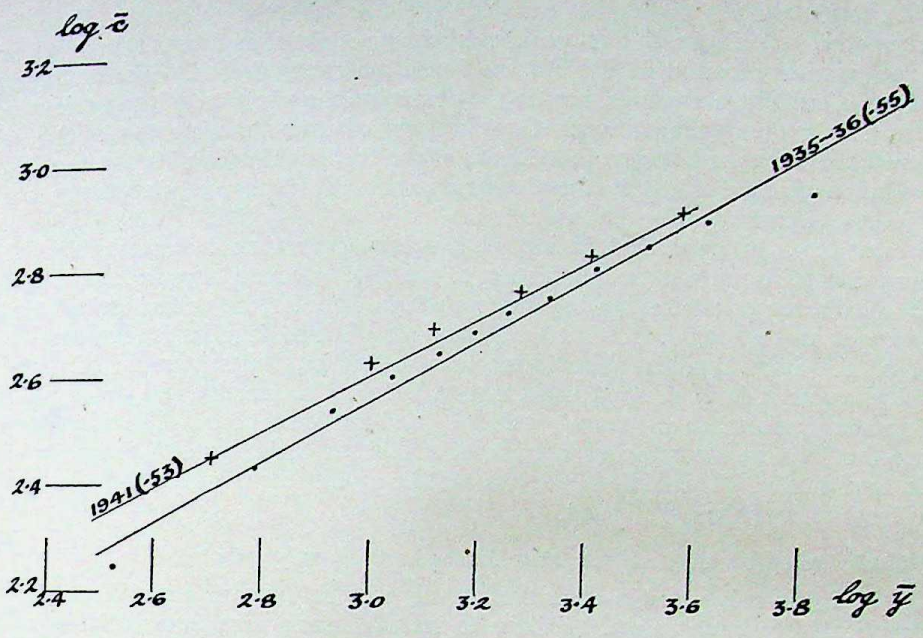

FIG. 3.—Rural non-farm families' income and food consumption.
● 1935–36.
+ 1941.

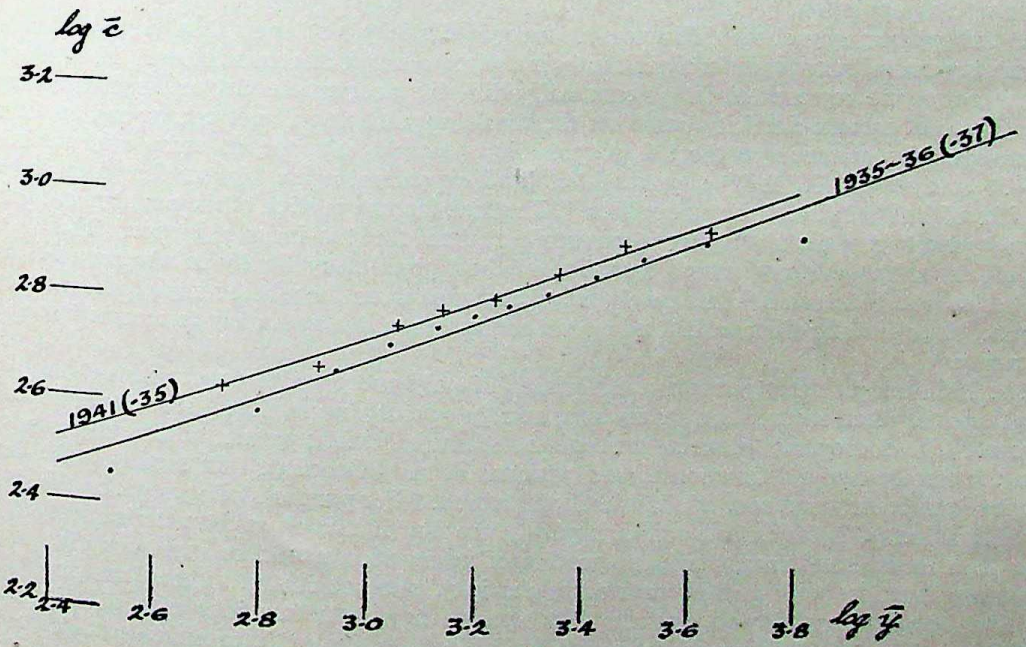

FIG. 4.—Rural farm families' income and food consumption.
● 1935–36.
+ 1941.

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per cent. of samples from a population in which the coefficients were equal. The exception is the pair of regressions 8 and 9; in this case the difference is not significant at the 1 per cent. level.

All the regressions reported in Table 4 are based on grouped data. None of these studies report budgets of individual families, nor do they estimate the variance of the basic observations about the means for the income-classes. Consequently a better statistical test of the significance of the differences among various sample estimates of the coefficient of $\log \bar{y}$ is not possible. These differences must be judged chiefly by the grosser criterion of the degree of accuracy to which the econometrician can aspire.

By this standard the agreement in income-elasticity over time is remarkable. The table contains no evidence to prevent the application of the 1941 estimate to previous or, indeed, post-war years. The error in attributing to rural non-farm families the urban estimate of income-elasticity appears to be negligible. But the behaviour of farm families is significantly different from that of non-farm families. The lower income-elasticity characteristic of farm families, and their higher mean level of food consumption relative to income, are probably associated with the greater importance of home-produced food in farm diets. The increase in urban expenditure for food as income rises represents a shift to higher-quality foods more than an increase in total intake. This shift is perhaps neither as easy nor as necessary for farmers who produce a large part of their own food.

1.5. *The Omission of Variables Other than Income and Family Size*

Family size is the only variable other than family income appearing in (6), the food demand function applicable to budget data. Failure to include family size as a variable would result in a biased estimate of income elasticity, because family size is correlated with income.

The omission of other variables may be a source of similar bias. Sub-groups of the population may not be homogeneous in food consumption behaviour; there may be significant geographical or occupational differences. These differences may be of two kinds:

(1) Sub-groups may have significantly different income elasticities. In this case the relationship of food consumption to family income could not properly be described by a single coefficient for the whole population.

(2) Sub-groups may show differences in income-elasticity no larger than can be attributed to sampling errors, but may differ significantly in their levels of food consumption. If, in addition, the subgroups are represented in systematically differing proportions at various income levels, the estimate of income-elasticity based on the whole population will not correspond to the true income-elasticity common to the subgroups. For example, suppose, as some evidence in the 1935–36 study (N.R.C., 1941) suggests, that food expenditures are highest for given incomes and sizes of family in Eastern metropolises. The high-income portion of the population contains relatively more families from these communities than the low-income groups. This will be reflected in a budget study whose sampling method gives every family in the population an equal chance to be selected. Income-elasticity computed from the whole sample will be an over-estimate, since it will reflect variation in food consumption due not solely to income but also to geography.

The 1941 budget study permits consideration of only one possible determinant of food consumption other than income and family size, namely type of community: urban, rural non-farm, or farm. The discrepancy between farm and non-farm behaviour presents a difficulty in passing from the family demand function to the national demand function. In section 2 the family function is to be summed over all families in the nation. For purposes of aggregation the simplicity of function (6) is of course a convenience. If the function involved characteristics of families other than income and family size the process of aggregation would be more complicated. If a separate function, with a different income-elasticity, were attributed to the farm population, it would be necessary also to estimate two separate aggregate functions with differing price-elasticities. The required time series are not available. The error of attributing urban behaviour to farm families must be accepted. It is desirable, therefore, to have some indication of its size. In 1941 use of the urban function to estimate farm consumption at all levels of family income yields an estimated average 5 per cent. below the actual average consumption of farm families. Since farm consumption was less than one-sixth of national food consumption the error from this source in estimating the average for all families is less than 1 per cent.

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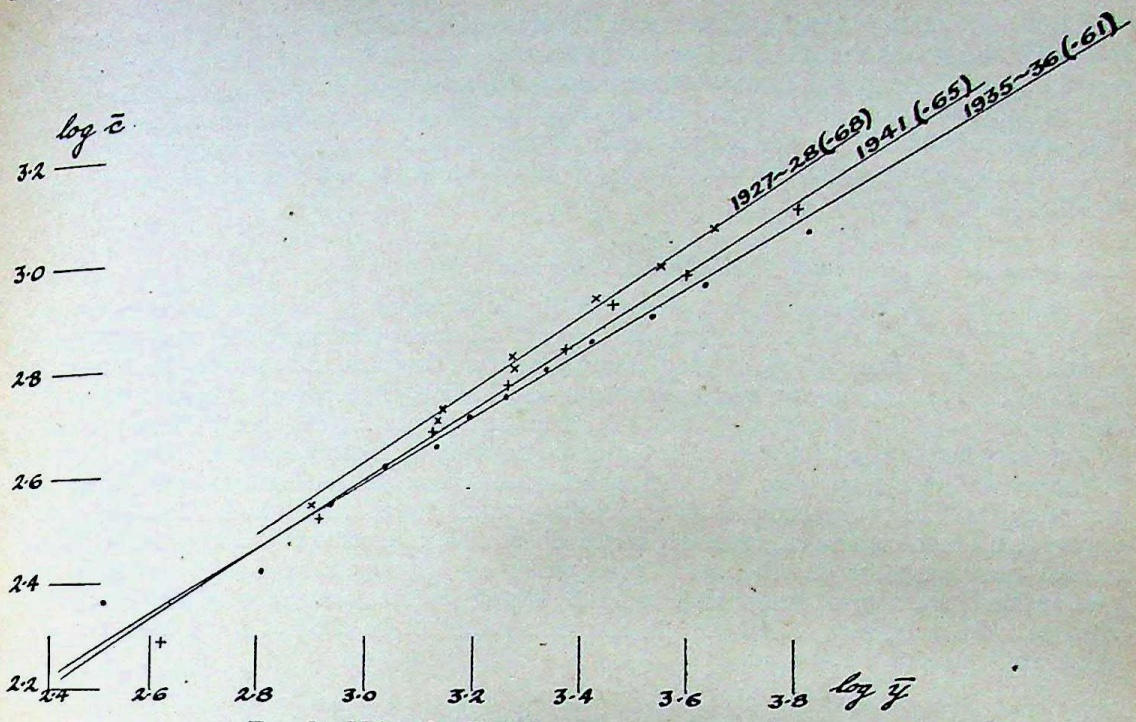

FIG. 5.—Urban families' income and food consumption.
× 1927–28.
● 1935–36.
\+ 1941.

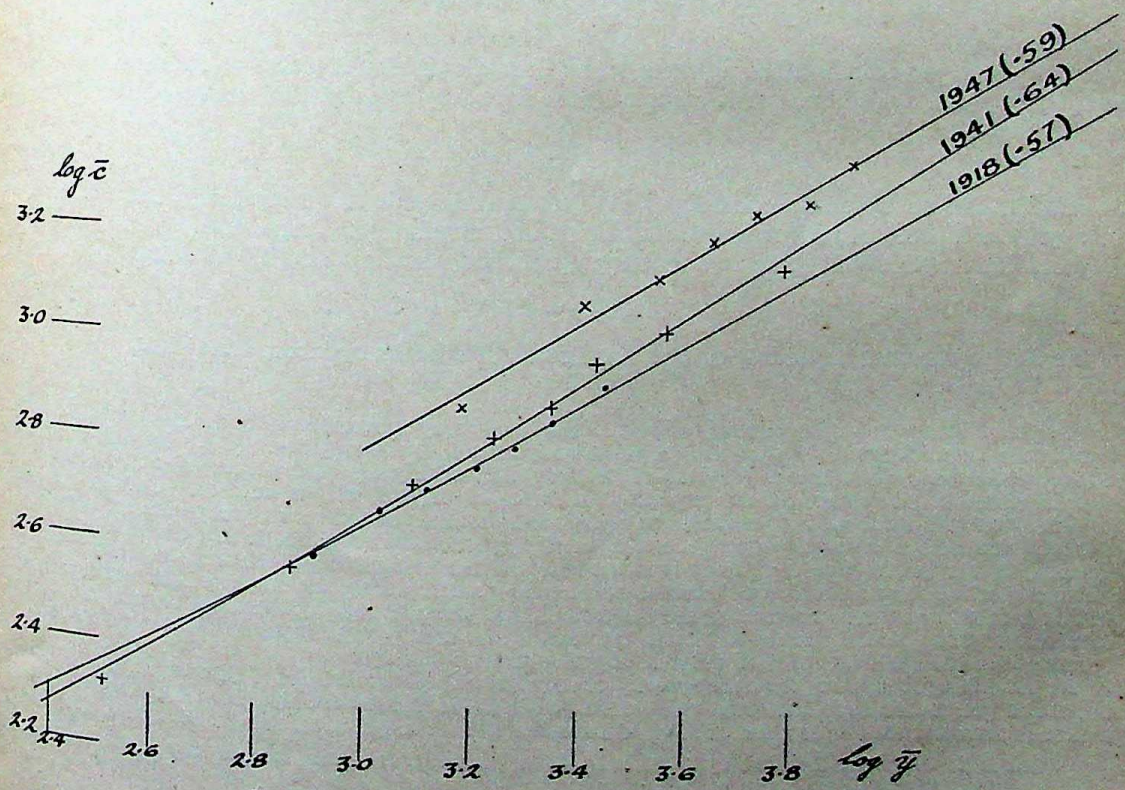

FIG. 6.—Urban families' income and food consumption.
● 1918.
\+ 1941.
× 1947 (Washington, D.C.).

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Within the urban population there may be divergences of behaviour which are concealed in the 1941 budget data and bias the estimate of income-elasticity. Occupation, size of city, and region may be determinants of food consumption, and the impossibility of allowing for them in the 1941 study may lead to errors.* These errors are the price paid for the advantages of the 1941 study, pointed out above, and for a family demand function which can be aggregated without involving in the national function a collection of variables which would place an impossible burden on available time series.

2. *Aggregation of the Family Food Demand Function*

The problem of aggregation is to derive from the relationship between family income and family consumption a relationship between aggregate income and aggregate consumption. In general aggregate consumption, given the family demand function, depends on the distribution of income, and not simply on the mean of the distribution. Moreover, if family consumption depends on variables other than income—such as family size, in the case of food—aggregate consumption depends on the joint distribution of families by income and these other variables. Whenever this joint distribution is known, an estimate of aggregate consumption can be made by weighting the family demand function according to the joint distribution. The problem of aggregation arises because estimates are required when mean income is the only available information concerning the distribution. Consequently any aggregate relationship requires some assumption concerning the manner in which the joint distribution changes when aggregate income changes. In the nature of the case the assumption cannot be checked every time it is used; otherwise it would not be needed.

2.1. *Aggregation under the Assumption of a "Constant" Income Distribution*

In the particular case of food demand, summing (6) over all families gives mean consumption:

$$C(Y) = k''_t \sum_{n=1}^{m} \int_0^{\infty} y^a n^\delta f(y, n; Y)\, dy. \qquad (12)$$

where m is the largest size of family and $f(y, n; Y)$ is the density function of the distribution of families by y and n when mean income is Y. The following assumption is made concerning this density function:

$$\lambda f(\lambda y, n, \lambda Y) = f(y, n, Y) \qquad \lambda > 0 . \qquad (13)$$

A sufficient but not necessary condition for (13) to be satisfied is that every family share a change in aggregate income in proportion to its income and remain of the same size.†

From assumption (13) it follows that aggregate food consumption (12) becomes:

$$C(Y) = Mk''_t\, Y^a \qquad (14)$$

where M is a constant depending on the distribution of families by income and size.‡

* Some evidence of the influence of region and size of city may be found in N.R.C. (1941), where urban families are classified, first, by four sizes of cities and, second, by five regions. Unfortunately they are not cross classified. Regressions for each of the four sizes of city will yield slopes of ·51, ·51, ·53 and ·46. Regressions for each of the five regions yield slopes of ·48, ·50, ·60, ·49 and ·46. Only in the case of the region with slope ·60 is it necessary to reject the hypothesis that these subgroups are samples from a population with a common slope. Once again the absence of individual family observations or of estimates of the variances of these observations about the income-class means makes a more satisfactory statistical test of the significance of these differences impossible. Since the slope for the whole sample (·57) is greater than for all but one of the subgroups, it is probable that it reflects differences in level of food consumption, due not solely to income but also to size of city or to region. But the errors due to ignoring these determinants of food demand do not appear to be large.

An interesting analysis of the heterogeneity of the family food demand function over various occupational and geographical groups, based on Dutch data for individual families, has been made by G. Stuvel and S. F. James at the Department of Applied Economics, Cambridge, *J. R. Statist. Soc.*, **113**, 59.

† This is the condition assumed by Marschak (1939*a*, p. 164, and 1943). It is stronger than necessary.

‡ The proof of (14) is as follows p 127 (footnote ‡):

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The same result can be reached from an assumption somewhat weaker than (13) if approximation (9) is used for the family demand function. In this case, knowledge of the entire joint distribution of y and n is not required; since the demand function is linear in n, it is sufficient to know the average family size corresponding to each income level. Let

$$g(y;\ Y) = \sum_{n=1}^{m} f(y, n;\ Y)$$

$$\bar{n}(y;\ Y) = \frac{\sum_{n=1}^{m} n f(y, n;\ Y)}{g(y;\ Y)}.$$

Then (13) can be replaced by the weaker conditions:

$$\lambda\, g\,(\lambda y;\ \lambda Y) = g(y;\ Y) \qquad \lambda > 0 \quad . \quad . \quad . \quad . \quad . \quad *(15)$$

$$\bar{n}\,(\lambda y;\ \lambda Y) = \bar{n}(y;\ Y) \qquad \lambda > 0 \quad . \quad . \quad . \quad . \quad . \quad (16)$$

Summing (9) over all families,

$$C(Y) = \int_0^{\infty} k''_t\, y^{\alpha}(a + b\,\bar{n}(y;\ Y))\, g\,(y;\ Y)dy \quad . \quad . \quad . \quad . \quad (17)$$

From assumptions (15) and (16) it follows that (17) becomes:

$$C(Y) = M' k''_t\, Y^{\alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

where M' is a constant.†

Under the assumptions made in this section, then, the demand function of Section 1 is preserved under aggregation. That is, the relationship between aggregate consumption and aggregate income is of the same form as the relationship between family consumption and family income, and the aggregate income-elasticity is equal to the family income-elasticity α.

---

‡

$$\text{Let } M(Y) = \sum_{n=1}^{m} \int_0^{\infty} \left(\frac{y}{Y}\right)^{\alpha} n^{\delta} f(y, n;\ Y)\, dy.$$

$$\text{Then } M(\lambda Y) = \sum_{n=1}^{m} \int_0^{\infty} \left(\frac{y}{\lambda Y}\right)^{\alpha} n^{\delta} f(y, n;\ \lambda Y)\, dy \qquad \lambda > 0$$

$$= \sum_{n=1}^{m} \int_0^{\infty} \left(\frac{\lambda y}{\lambda Y}\right)^{\alpha} n^{\delta} f(\lambda y, n;\ \lambda Y)\lambda\, dy$$

$$= \sum_{n=1}^{m} \int_0^{\infty} \left(\frac{y}{Y}\right)^{\alpha} n^{\delta} f(y, n;\ Y)\, dy \text{ by (13)}$$

$$= M(Y) \text{ for all } \lambda > 0.$$

* It can be shown that (15) is a necessary and sufficient condition for the invariance of the Lorenz curve under changes in mean income.

† (17) can be written:

$$C(Y) = (aM_1(Y) + b\, M_2(Y))\, k''_t\, Y^{\alpha}$$

$$\text{where } M_1(Y) = \int_0^{\infty} \left(\frac{y}{Y}\right)^{\alpha} g\,(y;\ Y)\, dy$$

$$\text{and } M_2(Y) = \int_0^{\infty} \left(\frac{y}{Y}\right)^{\alpha} \bar{n}\,(y;\ Y)\, g(y;\ Y)\, dy.$$

The proof that $M_1(Y)$ and $M_2(Y)$ are constants is analogous to the proof in the preceding footnote that $M(Y)$ is a constant. Strictly, (9) is an approximation of the family demand function for families of two or more persons. Assumptions (17) and (18) should apply only to $n \geq 2$ and (13) should be retained for $n = (1)$. Then if the proportion of single individuals to larger families is constant, the aggregate function $C(Y)$ will be of the form (14) or (18).

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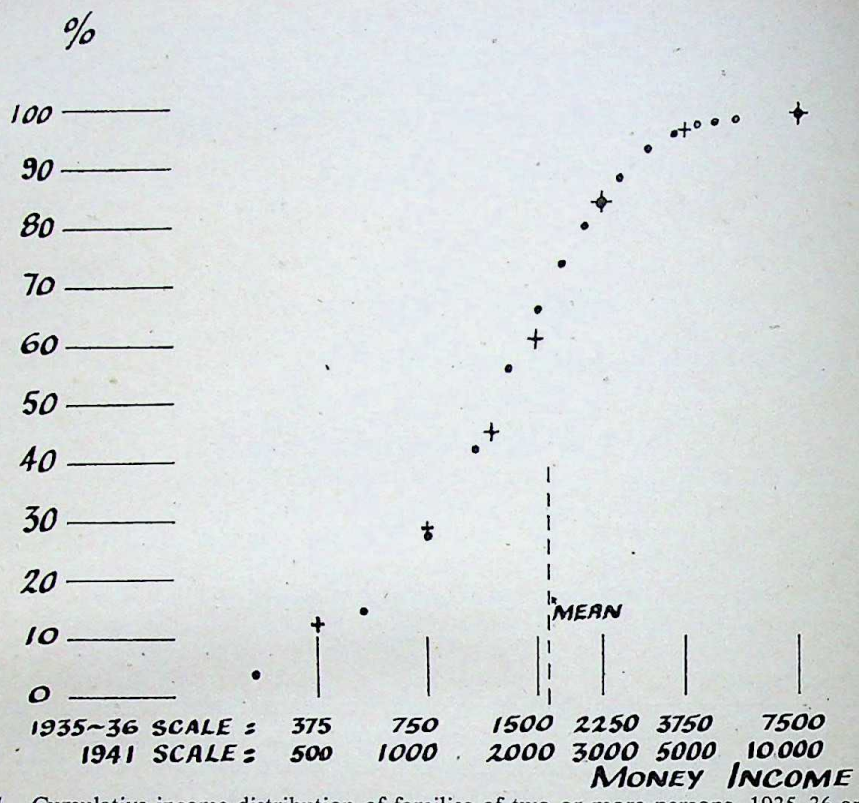

FIG. 7.—Cumulative income distribution of families of two or more persons, 1935-36 and 1941.
● 1935–36.
+ 1941.

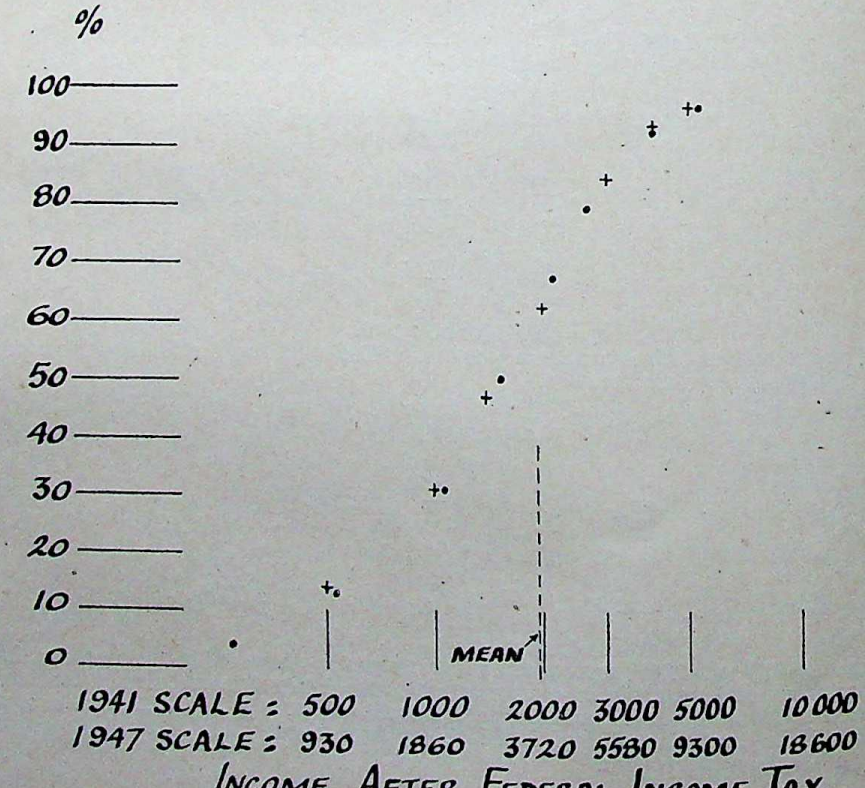

FIG. 8.—Cumulative income distribution of families, including single individuals, 1941 and 1947.
+ 1941.
● 1947.

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2.2. *Evidence Concerning the "Constancy" of the Income Distribution*

The reason for introducing the weaker assumptions concerning the income-family size distribution is that some data bearing on (15) are available. Fig. 7 presents the cumulative distributions of families of two or more persons by income for 1935–36 and 1941, based on the budget surveys for those years (N.R.C., 1939, Table 24A, p. 86, and B.L.S., 1945, Table 1, p. 68). In Fig. 7 the horizontal axis measures y/Y, the ratio of family income to mean income. The ordinate of each point gives the percentage of families whose incomes, relative to mean income, were lower than the abscissa. If assumption (15) is correct, plotting the distributions in this way should make the 1935–36 and 1941 points fall along the same curve. Fig. 8 is a similar comparison of the 1941 and 1947 cumulative distributions of families of all sizes by income after federal income tax (*Economic Report*, 1949; Table B–3, p. 93, and Table 2, p. 14).

The coincidence of the income distribution observations in different years, when plotted as in Figs. 7 and 8, is of course not conclusive confirmation of the invariance of the distribution either over time or with respect to changes in aggregate income.* It does indicate that, in the absence of time series of measures of income inequality,† the assumption of a constant degree of inequality will not lead to serious errors in statistical demand analysis.

Assumption (15) does not, of course, imply either (13) or (17). But if (15)—constancy of the Lorenz curve—is correct, errors of aggregation will be due to failure of the assumptions regarding the distribution of families by size. These errors are not likely to be large. For one thing, overall average family size is nearly constant over the period 1913–41, varying in the narrow range 3·20–3·36.‡ With a constant average family size, it would be difficult to have a reshuffling of the joint distribution of families by income and size which would change aggregate food consumption appreciably. Suppose, to take an extreme and unlikely example, that in the 1941 distribution the average size of families below the median income of $1,500 were cut in half and the average size of families with higher incomes increased by 35 per cent. This would leave average family size unchanged. It would increase aggregate food consumption, computed by (12) only 1 per cent.

2.3. *The Aggregate* per capita *Demand Function*

The aggregate demand function (14) or (18) expresses food consumption per family in terms of disposable income per family. For the purposes of section 3 it is more convenient to measure consumption and income *per capita*. In accordance with assumption (13) or (16), the average size of family N is taken to be constant; in fact, as pointed out above, it varied only slightly over the period under consideration.

Consequently (14) implies:

$$C' = \frac{M k''_t}{N^{1-\alpha}} Y'^{\alpha} \qquad (19)$$

where $C' = C/N$, *per capita* food consumption

and $Y' = Y/N$, *per capita* disposable income.

Substituting the value of k''_t from (6) gives the complete aggregate demand function:

$$C'_t = K Y'^{\alpha_1}_t Y'^{\alpha_2}_{t-1} P_t^{\beta} Q_t^{\gamma} \qquad (20)$$

where $K = \frac{Mk}{N^{1-\alpha}}$ is a constant.

3. *Estimation of Parameters from Time Series*

In accordance with sections 1 and 2, the sum of the two income-elasticities of food demand is taken to be ·56, both for the family demand function and for the aggregate demand function.

* Mendershausen (1946) has shown that inequality was greater in the depression year of 1933 than in the boom year of 1929, and has presented a convincing explanation of this phenomenon.

† The only time series on this subject are based on income tax statistics, and concern only the top of the income distribution. Consequently they are useless for the purposes of this paper.

‡ Computed by dividing annual U.S. population estimates (U.S. Department of Commerce, 1945, p. 8) by annual estimates of the number of consumer units in the U.S. (National Industrial Conference Board, 1948, p. 334).

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This sum must be split into an estimate of current-income-elasticity α_1, and an estimate of past-income-elasticity α_2. The two price elasticities β and γ must also be evaluated. The purpose of the present section is to obtain these estimates by multiple correlation of time series of aggregate data. The parameters, however, apply to the family demand function (1) as well as to the aggregate demand function (20). In section 4, therefore, the estimates obtained in this section are tested by applying them to family budget observations made in different years.

3.1. *A Simple Model of the Retail Food Market*

The procedure used in the time series correlation assumes the following simple model of the retail food market:

$$S_t = C'_t = K Y'^{\alpha_1}_t \, Y'^{\alpha_2}_{t-1} \, P_t^{\beta} \, Q_t^{\gamma} \quad . \quad . \quad . \quad . \quad . \quad (21)$$

where S_t is *per capita* food supply for domestic consumption. Y'_t, Q_t and S_t are assumed to be exogenous in the sense that none of them depends on the simultaneous values of the other variables in the system. Thus the supply of food, for example, may depend on the price of food in the preceding year, and still be a datum in the year in which it comes on the market.

Over the time period under consideration, 1913–41, both the *per capita* production of food and the *per capita* supply for domestic consumption were nearly constant. Total food production was insensitive in the short run to current economic conditions and was determined instead by weather, government policy, and the state of agricultural technique. The possibility remains that, even though food production may be considered exogenous to our model, the supply for domestic consumption may be influenced by the current price level of food. Changes in stocks of foodstuffs and sales abroad may depend on current prices. A significant relationship of this kind between supply and price would mean that use of the simple model would yield biased estimates of the parameters in the demand equation (Stone, 1948, p. 4, and Leontief, 1948). The possibility of bias from this source will be considered in section 3.4 below.

The assumptions that income and non-food prices are exogenous to the food market have less theoretical justification. But a model which would explain these variables would cover the whole economy, and the statistical estimation of the parameters in an all-inclusive model is much beyond the scope of this paper.

3.2. *The Multiple Regression*

The "reduced form" of the simple system (21) is an equation expressing P as a function of the three exogenous variables. In terms of the logarithms of the variables, the equation is:

$$\log P_t = -(1/\beta) \log K + (1/\beta) \log S_t - \left(\frac{\alpha_1}{\beta}\right) \log Y'_t - \left(\frac{\alpha_2}{\beta}\right) \log Y'_{t-1} - (\gamma/\beta) \log Q_t \, . \quad (22)$$

This equation can be written:

$$\log P_t = b_0 + b_1 (\log S_t - \alpha \log Y'_t) + b_2 (\log Y'_t - \log Y'_{t-1}) + b_3 \log Q_t \quad . \quad (23)$$

Since the value of α is taken as known, the constants b_0, b_1, b_2, b_3 can be estimated by multiple correlation of $\log P_t$ against three variables $(\log S_t - \alpha \log Y'_t)$, $(\log Y'_t - \log Y'_{t-1})$ and $\log Q_t$. The parameters of the demand function (20) can then be found as follows:

$$\beta = \frac{1}{b_1}, \quad -\gamma = \frac{b_3}{b_1}, \quad \alpha_2 = \frac{b_2}{b_1}, \quad \alpha_1 = \alpha - \frac{b_2}{b_1} \quad . \quad . \quad . \quad . \quad (24)$$

This multiple correlation has been computed from annual data for the 29 years 1913–41. The statistical series used to represent the variables are shown in Table 5 and described in the notes to that table.

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TABLE 5

Time Series of Food Consumption Per Capita, *Disposable Income* Per Capita, *Food Price-Index, Non-food Price Index, and Food Production* Per Capita

Year t	*Food consumption* S_t (*Index* 1935–39=100)	*Disposable income* Y'_t (*Dollars*)	*Food price* P_t (*Index* 1935–39=100)	*Non-food price* Q_t (*Index* 1935–39=100)	*Food production* Z_t (*Index*)
1912	..	332	..	..	..
1913	96	343	79·9	65·9	80
1914	97	335	81·8	66·7	82
1915	96	352	80·9	68·3	83
1916	96	408	90·8	71·2	79
1917	96	483	116·9	78·6	79
1918	95	534	134·4	93·7	86
1919	98	603	149·8	105·3	86
1920	97	627	168·8	130·5	82
1921	94	486	128·3	127	78
1922	99	517	119·9	119·5	83
1923	101	589	124	120·9	85
1924	102	584	122·8	121·9	85
1925	101	610	132·9	121·5	80
1926	102	623	137·4	120·7	83
1927	101	618	132·3	119·8	81
1928	102	625	130·8	118·4	83
1929	102	653	132·5	117·4	80
1930	100	574	126	116·1	80
1931	100	480	103·9	111	81
1932	98	365	86·5	103·4	77
1933	97	354	84·1	96·6	77
1934	99	403	93·7	96·7	79
1935	96	442	100·4	97	73
1936	99	509	101·3	97·8	76
1937	100	537	105·3	101·1	78
1938	100	485	97·8	102·3	79
1939	104	517	95·2	101·7	81
1940	105	552	96·6	102·3	84
1941	108	666	105·5	105·1	86
1945	114	1,070	139·1	122·9	..
1946	118	1,127	159·6	129	..
1947	117	1,205	193·8	141	..
1948	113	1,299	210·7	..	..

Sources and explanation of the series:

S_t: Cohen (1948), Table 1, p. 13. The 1948 figure is from *Economic Report* (1949), p. 54. The series is a price-weighted index of quantities computed by the U.S. Bureau of Agricultural Economics. It measures the disappearance of physical quantities of food to domestic civilian consumption. It does not measure changes in the amount of servicing of food in restaurants or retail outlets, nor does it measure in all cases changes in the amount of processing. For these reasons the series is not strictly comparable to the measure of food consumption in budget data, and it probably understates the amount of variation over time in the supply of "finished" foodstuffs.

Y'_t: Computed by dividing figures for national disposable income (Dewhurst *et al.*, 1947, Appendix 4, p. 696) by annual estimates of population (U.S. Department of Commerce, 1945, p. 8). The figures for 1945–48 are from *Economic Report* (1949), Table C–6, p. 104.

P_t and Q_t: U.S. Department of Commerce (1945), p. 423. The figures for 1945–48 are from *Economic Report* (1949), Table C–20, p. 119. Both series are based on the Bureau of Labor Statistics Consumers' Price Index for moderate-income families in large cities. The series P_t is the Bureau's food price index. The series Q_t is computed from the equation $w\,P_t + (1 - w)\,Q_t = I_t$, where I_t is the index for all items and w is the weight given food in the computation of I_t. (B.L.S., 1943, p. 13*a*.)

Z_t: Bureau of Agricultural Economics weighted index of physical production of foodstuffs (U.S. Department of Agriculture, 1948), adjusted for changes in population.

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The results of the regression are as follows:

Regression coefficients:

$b_1 = -1{\cdot}97 \quad (\pm {\cdot}27)$

$b_2 = -{\cdot}24 \quad (\pm {\cdot}16)$

$b_3 = -{\cdot}06 \quad (\pm {\cdot}14)$

$(R^2 = {\cdot}87)$

Demand function parameters:

$\alpha_1 = {\cdot}44$

$\alpha_2 = {\cdot}12$

$\beta = -{\cdot}51$

$\gamma = -{\cdot}03$

$\alpha + \beta + \gamma = {\cdot}02 \quad . \quad . \quad . \quad (25)$

In this regression, the coefficient of $\log Q_t$ differs insignificantly from zero, and the significance of the correlation is increased by omitting this variable. The results are then as follows:

Regression coefficients:

$b_0 = 2{\cdot}95$

$b_1 = -1{\cdot}88 \quad (\pm {\cdot}14)$

$b_2 = -{\cdot}2 \quad (\pm {\cdot}12)$

$(b_3 = 0)$

$(R^2 = {\cdot}87)$

Demand function parameters:

$\log K = 1{\cdot}57$

$\alpha_1 = {\cdot}45$

$\alpha_2 = {\cdot}11$

$\beta = -{\cdot}53$

$(\gamma = 0)$

$\alpha + \beta + \gamma = +{\cdot}03 \quad . \quad . \quad (26)$

Fig. 9 shows the actual time series of the food price index (P_t, not $\log P_t$) and the values of P_t estimated from regression (26). The correlation between the original and calculated series is ·93.

Confidence limits, with 95 per cent. probability, have been computed for β and α_2.* They are:

$$-{\cdot}63 < \beta < -{\cdot}46$$
$$-{\cdot}03 < \alpha_2 < {\cdot}24.$$

Taking α as known from budget data, confidence limits for α_1 can be derived from those for α_2:

$$·32 < \alpha_1 < ·59.$$

* The following method for computing these confidence limits was kindly pointed out to me by Mr. J. Durbin and Mr. G. Watson, Department of Applied Economics, University of Cambridge. In the case of a_2, consider $\frac{b_2 - a_2 b_1}{S(a_2)}$. Here b_2 and b_1 are the regression coefficients in (26) and $S(a_2)^2 = \text{var } b_2 + a^2_2 \text{ var } b_1 - 2a_2 \text{ covar } b_2 b_1 = s^2 \left[\frac{\Sigma x^2_1 + a^2_2 \Sigma x^2_2 + 2a \Sigma x_1 x_2}{\Sigma x^2_1 \Sigma x^2_2 - (\Sigma x_1 x_2)^2}\right]$, where $s^2 = \frac{N(1 - R^2) \text{ var } \log P}{N - 3}$, $x_1 = \log S_t - a \log Y't$, and $x_2 = \log Y't - \log Y't_{-1}$. Given any a_2, $\left(\frac{b_2 - a_2 b_1}{S(a_2)}\right)$ is distributed according to Student's t distribution with $N - 3$ degrees of freedom. Consequently, the probability that $\left(\frac{b_2 - a_2 b_1}{S(a_2)}\right)^2 < t^2_{·025} = ·95$, where $t_{·025}$ is the value of t exceeded with probability ·025, or exceeded in absolute value with probability ·05. Therefore $P[(b_2 - a_2 b_1)^2 < t^2_{·025} \ [S(a_2)]^2] = ·95$

$$P[b^2_2 + a^2_2 \ b^2_1 - 2a_2 \ b_1 b_2 - t^2_{·025} \ [S(a_2)]^2 < 0] = ·95$$

$(b^2_2 + a^2_2 \ b^2_1 - 2a_2 \ b_1 b_2 - t^2_{·025} \ S(a_2)^2)$ is quadratic in a_2 and can be represented by $(a_2 - c_1)(a_2 - c_2)$. Take $c_1 < c_2$. Then

$$P[(a_2 - c_1)(a_2 - c_2) < 0] = ·95.$$

But $(a - c_1)(a - c_2) < 0$ implies, since $c_1 < c_2$, $a_2 - c_1 > 0$ and $a_2 - c_2 < 0$, and therefore $c_1 < a_2 < c_2$.

$$P[(c_1 < a_2 < c_2)] = ·95.$$

A similar procedure applies to the case of β. Here $\left(\frac{1 - \beta b_1}{\beta \sigma_{b_1}}\right)$ is distributed by the t distribution with $N - 3$ degrees of freedom. Compare Fisher (1946), pp. 142–145.

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The sum of the estimates of elasticities in either (25) or (26) does not differ significantly from zero.* The results do not contradict the "homogeneity postulate" of economic theory.

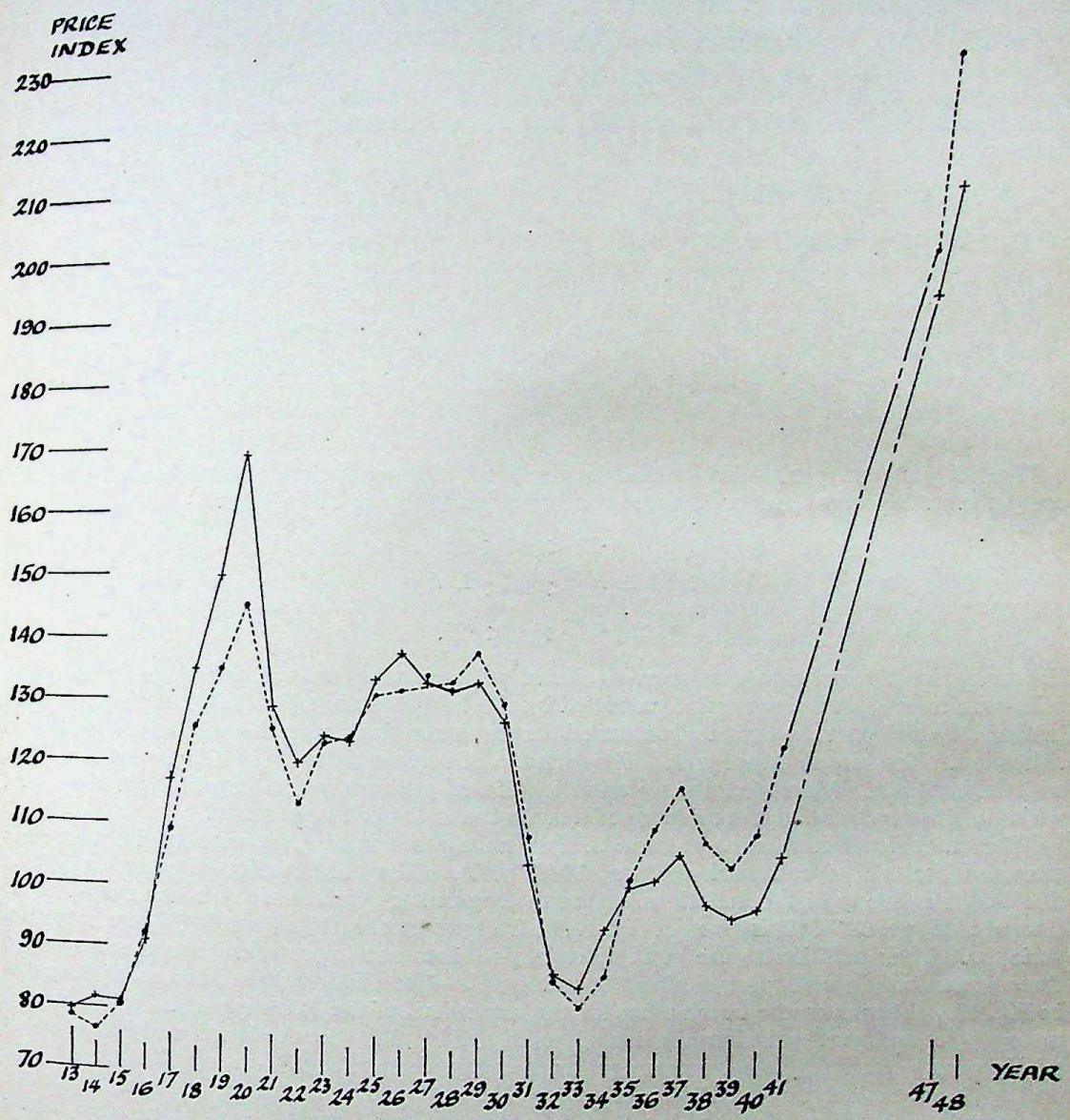

FIG. 9.—Food Price Index, 1913–41, 1947–48.
+ ———— Actual.
● - - - - - - Calculated from regression (26).

* This conclusion follows for (26) from testing the significance of the deviation of the estimate of $\beta(= \frac{1}{b_1} = -\cdot 53)$ from the assumed true value of $\beta(\bar{\beta} = -\alpha = -\cdot 56)$ according to the "homogeneity postulate." $\left(\frac{1 - \bar{\beta} b_1}{\bar{\beta}\, \sigma_{b_1}}\right)$ is distributed by Student's t-distribution with $N - 3 = 26$ degrees of freedom (see preceding footnote). With the estimates of (26) $t = -\cdot 66$. A deviation of β from $\bar{\beta}$ as large as or larger than that observed in (26) and in the same direction would be obtained in over 25 per cent. of samples. A deviation at least as large in absolute value would occur in over 50 per cent. of samples. A similar test, with similar results, can be made for the sum of the elasticities estimated in (25).

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3.3. *Estimates Obtained with No Restriction on the Parameters*

In the correlation just described, the sum of the two income-elasticities is taken as known from budget data. How do the estimates of the parameters obtained subject to that restriction compare with estimates based on time series alone? A multiple correlation, using the same variables, has been computed to estimate the constants in the following equation:

$$\log P_t = b_0 + b_1 \log S_t - b_2 \log Y'_{t-1} + b_3 \log Q_t + b_4 \log Y'_t \quad . \quad . \quad (27)$$

The coefficient b_2 is not significant. With $\log Y'_{t-1}$ omitted from the regression, the results are as follows:

Regression coefficients:

$b_1 = -3{\cdot}56\ (\pm\ {\cdot}42)$

$(b_2 = 0)$

$b_3 = {\cdot}22\ (\pm\ {\cdot}09)$

$b_4 = {\cdot}97\ (\pm\ {\cdot}09)$

$(R^2 = {\cdot}93)$

Demand function parameters:

$\alpha_1 = -b_4/b_1 = {\cdot}27$

$(\alpha_2 = b_2/b_1 = 0)$

$\beta = 1/b_1 = -{\cdot}28$

$\gamma = -b_3/b_1 = {\cdot}06$ . . (28)

The 95 per cent. probability confidence limits for the parameters of the demand function, computed in the same manner as those for regression (26), are as follows:

$${\cdot}22 < \alpha_1 < {\cdot}35$$

$$-{\cdot}38 < \beta < -{\cdot}23$$

$${\cdot}01 < \gamma < {\cdot}12.$$

The unrestricted correlation thus gives significantly lower numerical values for the income- and price-elasticities than the regression restricted by the budget-study estimate. But the regression in which the budget-study estimate is assumed fits the time series almost as well as the unrestricted regression. The reverse is not true. The estimate of income-elasticity in (28) is not consistent with budget data. Moreover, the rejection in (28) of previous year's income as a significant variable is contradicted by the evidence of a lag in the 1941–42 budget study.

The unrestricted correlation is more likely than the restricted regression to give unreliable estimates because of collinearity (Stone, 1948, p. 3). The vulnerability of equation (27) to this danger is due to high correlations among the explanatory variables. A bunch map analysis (Stone, 1945, pp. 306–310) is given in Fig. 10.* It shows that $\log Y'_{t-1}$ and $\log Q_t$ are not useful variables. Their addition to the multiple regression does not improve the bunch maps of the three regressions involving $\log P_t$, $\log Y'_t$, and $\log S_t$. (See the first three columns of diagrams in Fig. 10.) Moreover, the bunch maps for the regressions of $\log P_t$ on $\log Y'_{t-1}$ and of $\log P_t$ on $\log Q_t$ are exploded by the introduction of $\log Y'_t$ and $\log S_t$. (See the fourth and fifth columns of diagrams.) Similarly, the bunch maps for the regressions of $\log S_t$ on $\log Y'_{t-1}$ and $\log S_t$ on $\log Q_t$ are exploded by adding the other variables. (See the last two columns of diagrams.) The correlations of $\log Y'_{t-1}$ and $\log Q_t$ with $\log Y'_t$ and $\log S_t$ are too high to enable α_2 and γ to be estimated from time series alone. But if these other variables influence food consumption—and budget data indicate that lagged income, at least, does—the estimates of α_1 and β will reflect their influence.

The restricted correlation is less vulnerable to this kind of error. The independent variables in regression (23) are not the highly correlated variables which appear in (27). The introduction

* In Fig. 10 the numbers 1, 2, 3, 4, 5 refer, respectively, to $\log S_t$, $\log Y'_{t-1}$, $\log Q_t$, $\log Y'_t$, $\log P_t$. The label on each diagram indicates both the partial regression to which it refers and the set of variables in the complete regression. Thus diagram 51.42 shows the regression coefficients of 5 on 1 in the four regressions involving 5, 1, 4 and 2. The slope of a beam indicates the value of the normalized regression coefficient, and the number at the end of beam indicates the direction of minimization of the regression.

Fig. 10 is not a complete bunch map analysis for the five variables, because it is clear on economic as well as statistical grounds that 1, 4, 5 must be included in the regression.

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of an outside estimate of α permits a transformation of the variables which eliminates most of the correlation. Between the two explanatory variables used in (26) the correlation is $-\cdot 20$.

3.4. *The Possibility of Bias due to a Relationship between Supply and Prices*

The danger that a relationship between food supply and price might bias the estimates of the parameters in the demand equation has already been mentioned. The present section fulfils the promise to investigate the possibility by fitting supply and demand equations simultaneously.

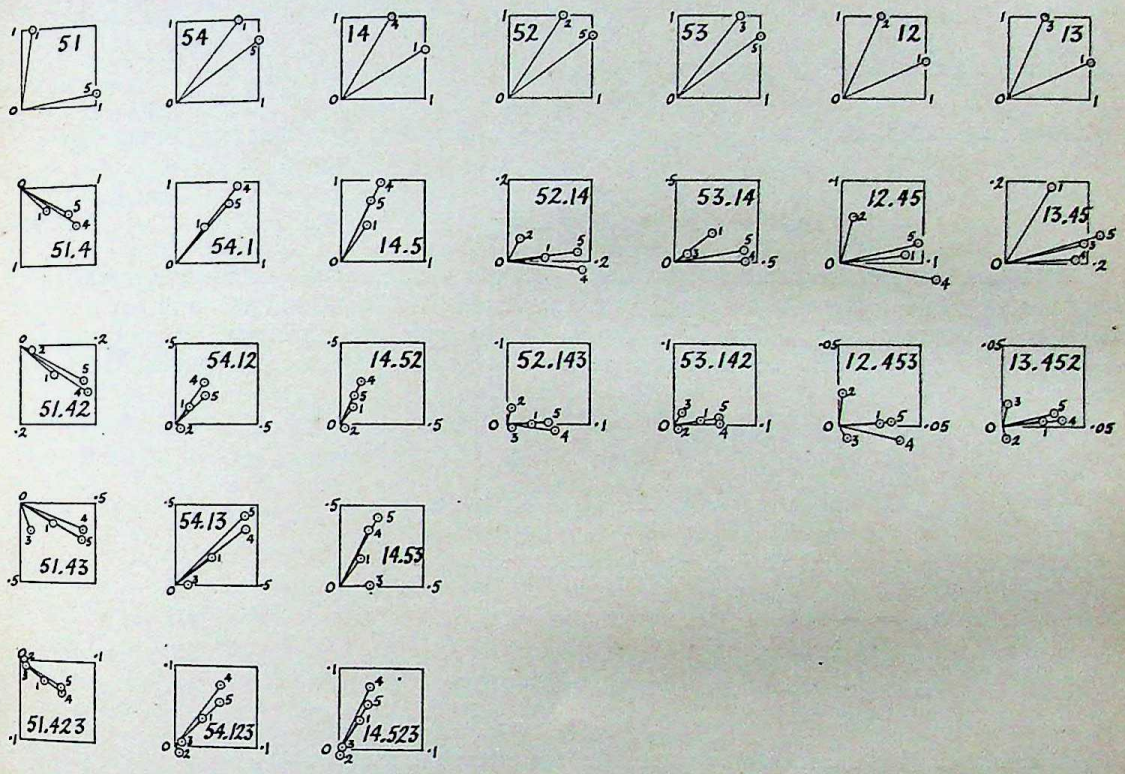

FIG. 10.

The two equations of the model are:

$$S_t = KY'^{\alpha}_t P_t^{\beta} Q_t^{\gamma} \quad \text{Demand}$$
$$S_t/Z_t = AP_t^{\beta'} Q_t^{\gamma'} \quad \text{Supply} \qquad . \quad . \quad . \quad . \quad . \quad (29)$$

In this model *per capita* domestic food supply is no longer assumed to be exogenous. Instead, *per capita* food production, Z_t, is taken as a predetermined variable. The supply equation states that the share of production going into the domestic retail market depends on food prices and on other prices. A serious study of the determinants of food supply would involve other variables and a more complicated scheme (Girschick and Haavelmo, 1947). The purpose of model (29) is only to discover whether the influence of current prices on supply is strong enough to bias the single-equation estimates of the demand parameters. In the demand equation of (29), α is assumed to be known. For the sake of simplicity, past income Y'_{t-1} is omitted from the demand function and α is entirely assigned to current income.

Expressed in terms of logarithms measured from their means, the system is:

$$\log S_t - \alpha \log Y'_t - \beta \log P_t - \gamma \log Q_t = u_{1t} \quad \text{Demand}$$
$$\log S_t - \beta' \log P_t - \gamma' \log Q_t - \log Z_t = u_{2t} \quad \text{Supply} \qquad . \quad . \quad (30)$$

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Here u_{1t} and u_{2t} are stochastic variables assumed to be distributed normally with zero means. System (30) can be reduced to two equations, one expressing $\log P_t$ and the other $\log S_t$ in terms of the independent variables:

$$\log P_t - \frac{\alpha}{\beta'-\beta}\log Y'_t - \frac{\gamma-\gamma'}{\beta'-\beta}\log Q_t + \frac{1}{\beta'-\beta}\log Z_t = v_{1t}$$

$$\log S_t - \frac{\beta'\alpha}{\beta'-\beta}\log Y'_t - \frac{\beta'\gamma-\beta\gamma'}{\beta'-\beta}\log Q_t + \frac{\beta}{\beta'-\beta}\log Z_t = v_{2t} \quad . \quad . \quad (31)$$

where:

$$v_{1t} = \frac{u_{1t}-u_{2t}}{\beta'-\beta} \text{ and } v_2 = \frac{\beta' u_{1t} - \beta u_{2t}}{\beta'-\beta}$$

are distributed normally with means zero.

Since α is known, and since $\frac{\beta}{\beta'-\beta} = \frac{\beta'}{\beta'-\beta} - 1$, these two equations may be rewritten:

$$\log P_t - b_{11}(\log Z_t - \alpha \log Y'_t) - b_{12}\log Q_t = v_{1t}$$
$$(\log S_t - \log Z_t) - b_{21}(\log Z_t - \alpha \log Y'_t) - b_{22}\log Q_t = v_{2t} \quad . \quad . \quad (32)$$

Maximum likelihood estimates of b_{11} and b_{12} can be obtained by least squares regression of $\log S_t$ on $(\log Z_t - \alpha \log Y_t)$ and $\log Q_t$, and maximum likelihood estimates of b_{21} and b_{22} can be obtained by regression of $(\log S_t - \log Z_t)$ on the same two variables. From these four coefficients maximum likelihood estimates of the four unknown structural parameters can be derived:

$$\beta = \frac{b_{21}+1}{b_{11}} \qquad \gamma = b_{22} - \beta b_{12}$$
$$\beta' = \frac{b_{21}}{b_{11}} \qquad \gamma' = b_{22} - \beta' b_{12} \quad . \quad . \quad . \quad . \quad . \quad (33)$$

The estimates of the regression coefficients are as follows:

$$b_{11} = -1{\cdot}06 \ (\pm {\cdot}35) \qquad b_{12} = {\cdot}29 \ (\pm {\cdot}19) \qquad (R^2 = {\cdot}65)$$
$$b_{21} = -{\cdot}15 \ (\pm {\cdot}11) \qquad b_{22} = -{\cdot}02 \ (\pm {\cdot}06) \qquad (R^2 = {\cdot}1) \quad . \quad . \quad (34)$$

These estimates give the following values for the structural parameters:

$$\beta = -{\cdot}80 \qquad \gamma = {\cdot}21$$
$$\beta' = {\cdot}14 \qquad \gamma' = -{\cdot}06 \quad . \quad . \quad . \quad . \quad . \quad (35)$$

However, the fit of the second reduced form equation is extremely poor. The multiple correlation coefficient is not significant at the 5 per cent. level (Snedecor, 1946, Table 13.6, p. 351). The hypothesis that both b_{21} and b_{22} are zero cannot be rejected. Even if $\log Q_t$ is omitted, the regression is not significant; a correlation between $\log S_t/Z_t$ and $(\log Z_t - \alpha \log Y'_t)$ numerically as large as observed could occur in over 10 per cent. of samples from a population in which the correlation is zero. If b_{21} and b_{22} are zero, so are the supply equation parameters β' and γ'. Consequently, the hypothesis that β' and γ' are zero cannot be rejected. But if β' and γ' are zero, the supply relation is reduced to

$$\log S_t = \log Z_t + u_{2t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (36)$$

Provided that u_{2t} is not correlated with u_{1t}, the error term in the demand equation, the maximum likelihood estimates of the demand parameters are the single-equation estimates. The fact that $\log S_t$ appears in both the demand and supply equations is now irrelevant. The only danger in ignoring (36) is that u_{1t} and u_{2t} are correlated. The error terms u_{2t} are a known observed series $(\log S_t - \log Z_t)$. Fitting the demand equation so as to maximize the probability that its errors and the known errors u_{2t} come from a joint normal distribution makes no more sense

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than considering the possibility that the errors u_{1t} are correlated with any other observed series. (Compare Leontief (1948), p. 400.) In any case (36) is not a convincing hypothesis; the correlation (·38) between log S_t and log Z_t is barely significant.

The investigation of this section gives no reason for rejecting the hypothesis of the initial single-equation model that food supply is an exogenous variable. There is no evidence of a significant relationship between supply and prices. Whatever bias may be introduced by ignoring a possible supply relation is surely preferable to the wide bands of error attached to estimates based on the two-equation model.

3.5. *The Problem of Serial Correlation*

One more statistical difficulty must be considered (Stone, 1948, p. 12). The parameter estimates of (26) were obtained under the assumption that equation (23) is satisfied every year subject to an error which is distributed independently of the errors in previous years. This assumption is contradicted by the time series of the estimated residuals. The differences between actual food price and food price calculated from the regression show a cyclical pattern (see Fig. 9). They also show an over-all downward trend: actual price tends to fall relative to calculated price. The ratio (δ^2/s^2) of the mean square successive difference of the residuals to the variance of the residuals is ·68. So low a value would occur in less than 0·1 per cent. of samples of this size from a population in which the errors in different years are independently distributed (Hart, 1942).

The addition of a time trend to the multiple regression does not eliminate serial correlation. The cyclical pattern of the residuals remains. The ratio δ^2/s^2 is increased to 1·08, but this is still significant at the 1 per cent. probability level.

A correlation has been computed using the first differences of the variables involved in regression (26). The results are as follows:

Regression coefficients:		Demand parameters:	
$b_1 = -1{\cdot}74$	$(\pm\ {\cdot}18)$	$\beta = -{\cdot}57$	
$b_2 = -{\cdot}08$	$(\pm\ {\cdot}08)$	$\alpha_2 = {\cdot}05$	(37)
$(R^2 = {\cdot}82)$			

These estimates of the demand parameters are well within the confidence limits for the estimates based on regression (26). Correlation of first differences does not yield significantly different estimates from correlation of the original variables. But the residuals of the regression of first differences do not show the auto-correlation evident in the residuals of the other regression. The ratio δ^2/s^2 is 1·99—not significant; indeed, the expected value of this ratio for samples of 28 from a population where the errors are not auto-correlated is 2·07.

3.6. *Application to Post-war Experience*

Post-war data offer a considerable challenge to any formula for food demand based on pre-war experience. The war-time expansion of agricultural production has raised the *per capita* supply of food some 15 per cent. above the level which persisted with only slight variation over the period 1913–41. Consumer income, in real or money terms, has far exceeded any previous peace-time levels. The price variables too have been carried by inflation beyond the range of experience from which a statistical formula must be derived. The war may have distorted the operation of any time trend detected in peacetime. Abnormal influences on consumer demand—the backlog of demand for durable goods, the extraordinary accumulation of savings during the war, the continuation of rent control—may have indirect repercussions on food expenditure. Finally, years within which prices and other variables change markedly are not a promising period for application of a function in which each variable covers an entire year.

In extrapolating a demand function to new ranges of aggregate income, the use of budget data to estimate income-elasticity has, in theory at least, an advantage over exclusive reliance on time series. Aggregate income may be unprecedentedly high without taking the bulk of families beyond the range of family incomes observed in budget data. An estimate of income-

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elasticity derived from budget data, applied to a record level of aggregate income, is not necessarily being employed beyond the range of the observations on which it is based.

Judged by food demand functions based solely on pre-war time series, the inflation of food prices after the expiration of price control and the increasing share of consumer income devoted to food expenditure were a mystery. The Department of Commerce found food expenditure in 1948 eight billion dollars more than expected from its pre-war regression of aggregate income and food expenditure (Gilbert, 1948, and Cohen, 1948). The food demand function of Girschick and Haavelmo (1947), obtained by estimating the parameters of this function simultaneously with those of other equations embracing the entire economy, fails to indicate an inflationary gap in food at the end of price control in 1946, or during the inflation of 1947.*

Thanks to the use of budget data, the statistical food demand function obtained in this study contains a higher estimate of income elasticity than functions based on time series alone (·56 compared to ·3 in the Girschick-Haavelmo study).† The function estimated in (26) correctly shows excess demand in 1946. Table 6 compares the actual averages of the food price index for three post-war years with values of the index "predicted" by (26); the comparison is also shown in Fig. 9.

TABLE 6

Average of Food Price Index

Year	*Actual*	*"Predicted"*
1946	160	185
1947	194	201
1948	211	232

4. *The Family Food Demand Function Over Time*

The estimates of elasticities obtained in section 3 are intended to apply to the family demand function as well as to the aggregate demand function. In section 1.4 it was shown that budget observations for different years agree fairly well in regard to the slope of the line relating the logarithms of food expenditure and income. They differ, as inspection of Figs. 3–6 readily reveals, in the level of this line. These differences in level should, according to the family demand function assumed in section 1, be explained by differences in variables other than current income. The purpose of this section is to see to what extent this explanation is possible.

The family food demand function (1) gives food consumption in physical units or in constant food dollars. For expenditure x_t in current dollars the function becomes—

$$x_t = c_t P_t = k y_t^{\alpha_1} y_{t-1}^{\alpha_2} P_t^{\beta+1} Q_t^{\gamma} n^{\delta} \quad . \quad . \quad . \quad . \quad (38)$$

By assumption (4) concerning the relation of current to past income, the expenditure function is:

$$x_t = k y_t^{\alpha} \left(\frac{Y_{t-1}}{Y_t}\right)^{\alpha_2} P_t^{\beta+1} Q_t^{\gamma} n^{\delta} \quad . \quad . \quad . \quad . \quad . \quad (39)$$

For a given year t, P_t, Q_t, and Y_{t-1}/Y_t are constant over all families. If the observations in a budget study for that year are adjusted to a standard family size $\hat{n}$, the relationship between current income and food consumption which the budget data should obey is—

$$x_t = m_t y_t^{\alpha}$$

where

$$m_t = k\left(\frac{Y_{t-1}}{Y_t}\right)^{\alpha_2} P_t^{\beta+1} Q_t^{\gamma} \hat{n}^{\delta} \quad . \quad . \quad . \quad . \quad . \quad (40)$$

For two years i and j:

* For the year 1946 their food demand function yields a *per capita* demand 114 per cent. of average consumption for 1935–39, and for 1947, 110 per cent. Actual food supply for domestic consumption was 118 per cent. in 1946 and 117 per cent. in 1947.

† Stone (1945), pp. 325–26, obtains from time series 1929–41 estimates of α and β which agree closely with the estimates of this paper. However, his estimate of γ (approximately ·55) is radically different.

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$$\frac{m_i}{m_j} = \left(\frac{P_i}{P_j}\right)^{\beta+1} \left(\frac{Q_i}{Q_j}\right)^{\gamma} \left(\frac{Y_{i-1}}{Y_i}\right)^{\alpha_2} \left(\frac{Y_{j-1}}{Y_j}\right)^{-\alpha_2} \quad . \quad . \quad . \quad . \quad (41)$$

If this ratio exceeds one, the logarithmic income-expenditure line should be higher for year i than for year j. Given the estimates of β, γ and α_2 obtained in (26) and the values of P_t, Q_t, Y_{t-1} and Y_t in the two years, the ratio can be computed. Table 7 shows its value for five years, with $j = 1941$ in each case.

TABLE 7

Calculated Values of m_i/m_j

$i =$	$(j = 1941)$
1918 .	1·13
1927–28 .	1·16
1935–36 .	·99
1941 .	1
1947 .	1·35

The levels of the logarithmic income-food expenditure lines based on budget observations in those five years should correspond in rank to the numbers in Table 7. Except for 1918, the ranks of the budget study lines with respect to level are consistent with the hypothesis (Figs. 3–6).

The amount as well as the direction of the shift in the income-consumption lines can be measured and compared with the calculated shift ratios. Lines were fitted by least squares to the observations shown on Figs. 3–6. Comparison of the levels of these lines is unambiguous only if they are of the same slope. Actually the slopes computed by regression differ slightly (Table 4). Therefore, in each comparison of two budget studies the mean of the two least squares slopes is taken as the slope for both lines. The level constant is then chosen so as to obtain the line of best fit with the given slope. For two years i and j we have two lines:

$$\log x_i = a_i + b \log y_i$$
$$\log x_j = a_j + b \log y_j.$$

This pair of lines provides the material for an independent estimate of the shift ratios already calculated, namely anti-log $(a_i - a_j)$. If families behaved over time exactly according to the statistical demand function, this would be equal to m_i/m_j. The two estimates of shift ratios are compared in Table 8.

TABLE 8

Shifts in Urban Income—Food Consumption Relationship

Budget studies compared		*Observed shift*	*Calculated shift*
i	j	(*antilog* $(a_i - a_j)$)	(m_i/m_j)
1935–36			
1918	1941 .	0·95 .	0·99
1927–28	1941 .	0·94 .	1·13
1927–28	1941 .	1·09 .	1·16
1947 Washington	1935–36 .	1·14 .	1·15
1947 Manchester	1941 .	1·3 .	1·35
1947 Richmond	1941 .	1·39 .	1·35
	1941 .	1·24 .	1·35

Summary and Conclusion

This investigation of food demand in the U.S. has been an experiment in the combination of time series and budget data in statistical demand analysis. The aggregate food demand function has been derived from a family food demand function, and the parameters of both functions have been estimated. Some estimates, applicable to both functions, have been obtained from

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budget data, and the remaining parameters have been evaluated from time series. Finally, the estimates have been checked by reference to budget observations made in different years.

Refinement of the method is certainly necessary. In particular, estimates from budget data should not be introduced into time series correlation as known with certainty. A maximum likelihood estimate of income-elasticity, for example, would utilize the two kinds of data simultaneously. The practical obstacle to this improvement is the absence of individual family observations in most published budget surveys; the use of grouped data, with no knowledge of the variation of families about the group means, gives a deceptive appearance of precision to budget study estimates. The discrepancy between budget study and unrestricted time series estimates of the same parameter should be eliminated by the use of additional variables to a greater extent than was possible in this study. But this experiment indicates, it is hoped, that further use and development of the method will be fruitful in statistical demand analysis.

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Discussion on Dr. Tobin's Paper

Mr. J. R. N. Stone: It gives me great pleasure to move a vote of thanks to Dr. Tobin on his excellent Paper. In recent years the Society has had presented to it Papers on demand analysis based on time series (such as my Paper in 1945) and on budget studies (such as J. L. Nicholson's Paper in 1949), but it has not before received one which made systematic use of both these sources. By his ingenious and skilful combination of these two kinds of information Dr. Tobin has produced a demand function which fits in with each. The superiority of his methods is demonstrated by the fact first that they do not simply reproduce earlier results but lead to different values for some of the parameters, and second that, unlike these earlier studies, they give good results when used to predict the level of the demand for food after the war. The Paper is one of which the author and the Society may justly be proud.

An interesting feature of the Paper is the use of the 1941 budget enquiry to demonstrate the need for including past incomes, a need not apparent from a study of time series alone. By assuming that the distribution of income is unchanged in a certain sense between last year and this, Dr. Tobin demonstrates that the income elasticity derived from budget studies will approximate to the sum of the elasticities with respect to this year's and last year's income. By an extension of his argument it can be seen that, on the same assumption about the constancy of the distribution of income, the income elasticity derived from budget studies will approximate to the sum of the elasticities with respect to current and past incomes, and so will approximate to the ultimate response of consumption to a given change in income not all of which, unless $\alpha = \alpha_1$, will be felt in the first year of this change. Furthermore, since the levels of income in the recent past (which is the important period) are highly but by no means perfectly correlated with present income, analyses based on time series which make use of present income only will tend to underestimate the importance of income in determining consumption. If past incomes are introduced without restriction on the income parameters the effect, usually small, of past incomes is likely to be masked and hard to determine.

Examples such as this justify, if justification is needed, the detailed econometric methods which Dr. Tobin has employed. The remaining matters I wish to discuss relate to some of the data he has used and to a comparison of his results with earlier investigations.

In the budget data used, total food expenditure is measured, and so a full allowance is made for the cost of processing food and for the various services connected with food whether in retailing or in the catering trade. The time series for food consumption on the other hand is a retail price-weighted index of the quantity of foodstuffs, prepared by the Bureau of Agricultural Economics (for a brief description see "Food Consumption, Expenditures and Prices," by Morris Cohen, in the *Survey of Current Business*, January, 1948). As Dr. Tobin points out, it does not measure changes in the amount of services rendered by caterers or in retail outlets nor in all cases does it measure the amount of processing involved. As can be seen from Table 5, it is remarkably stable over the period 1913–41, and the main justifications for using it are that it is the only uniform series available over the whole period and that it is the series used in an elaborate study by Girschick and Haavelmo (see "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations," in *Econometrica*, April, 1947). From 1929 onwards the Department of Commerce has prepared (National Income Supplement to *S.C.B.*, July, 1947) as part of its study of aggregate consumers' expenditure a series of total food expenditure which conceptually is more nearly related to the budget data than the series used by Dr. Tobin. This series can be deflated by means of the food component of the cost of living index but the trouble with it is that it cannot easily be taken back to 1913. Some information for the earlier years is given in the pioneer study of W. H. Lough (*High-Level Consumption*, 1935) and a very rough attempt may be made to interpolate this series for non-census years by means of a series given by W. H. Shaw (*Value of Commodity Output since 1869*, 1947). This pieced-together series shows, even when alcoholic drinks are removed from it following the repeal of prohibition, a movement different from and much more variable than that shown by the Bureau of Agricultural Economics index. Inasmuch as this series, while statistically lacking in uniformity, is conceptually more appropriate, I have included analyses based on it in the comparative table given below. For want of a better label I have referred to these analyses as Tobin-Stone without in any way wishing to implicate Dr. Tobin in the use of such a dubious statistical series.

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Comparison of Demand Analyses for Food in the United States of America

	Period	α_1	α_2	β	γ	Σ
Tobin:						
(1)	1913–41	0·44	0·12	−0·51	−0·03	0·02
(2)	,,	0·45	0·11	−0·53	—	0·03
(3)	,,	0·27	—	−0·28	0·06	0·05
Girschick and Haavelmo:						
(4)	1922–41	0·25	0·05	−0·25	0	0·05
Stone:						
(5)	1929–41	0·59	—	−0·58	−0·01	0
(6)	,,	0·53	—	−0·62	0·55	0·46
(7)	,,	0·83	—	−0·90	0·07	—
Tobin-Stone:						
(8)	1913–41	0·61	−0·05	−0·43	−0·11	0·02
(9)	,,	0·62	0·12	−0·39	−0·31	0·04
(10)	,,	0·69	0·12	−0·51	−0·29	0·01

Analyses (1) to (4) are based on the Bureau of Agricultural Economics series of food consumption, while analyses (5) to (10) are based on the Department of Commerce series continued backwards in the case of the last three by the method outlined above. In analyses (4), (6) and (7) allowance was made for a residual trend but this was not done in any of the others. Analysis (4) used a linear equation while in all the others the expression used was linear in the logarithms of the variables. In analyses (1), (2) and (8) but not in the others a restriction was placed on the sum $\alpha_1 + \alpha_2$. A zero indicates the estimated value of a parameter whereas a "—" indicates that the parameter in question was assumed to be zero or, in the final column (analysis (7)), that the sum $\alpha_1 + \beta + \gamma$ was restricted *a priori* to zero.

The first point to notice is that apart from (6) (and (7), which does not count in this connection) the sums of the elasticities shown in the final column are close to zero. This indicates that the proportionality condition is approximately satisfied in each case, which is in accordance with theoretical expectations. Second, the mean values of the parameters in (4) are similar to those in (3) so that the objection to (3) that they do not square with what is known from budget studies can equally be raised against the results of Girschick and Haavelmo as it can against Dr. Tobin's unrestricted equation. Third, (5), apart from the fact that no allowance is made for last year's income, gives results very close to (1). It was not, however, given in my original article ("The Analysis of Market Demand," this *Journal*, pts. III–IV, 1945) because, while it showed a closed bunch map and a high coefficient of multiple correlation, it also showed a highly systematic residual which could be removed by the introduction of a residual trend with the effect on the parameters here listed shown in (6). Thus, of the two equations which I did give, (6) was unsatisfactory since the proportionality condition was so far from being satisfied, while (7) was unsatisfactory since it involved such a large negative residual trend.

Finally, the last analyses make use of the extended Department of Commerce series. In all cases the value of α_1 is substantially higher than in (1) and (2). In (8), where a restriction is placed on the sum $\alpha_1 + \alpha_2$, a negative (though not significant) value is found for α_2 which is not consistent with budget data. In (9) and (10) the income elasticities are determined without restriction. In (9) food consumption is treated as the dependent variable as in (5) to (7), whereas in (10) the food price index is treated as the dependent variable as in (1) to (3). These two analyses do not revert to the values of α_1 given by (3); on the contrary the values obtained are consistently above, not below, those derived from (1) and (2). In addition the value of α_2 is in each case the same as in (1) so that the unrestricted income effect exceeds the value obtained from budget data. This increased effect of income is largely offset by substantial negative values of γ. Thus the use of this alternative series which, for all its shortcomings, seems more appropriate than the one used by Dr. Tobin for combination with the budget data he has used, leads to results which still stand in need of reconciliation. There is clearly a need for a more satisfactory time series of food expenditure at constant prices for the years before 1929 than anything available at present.

Mr. NICHOLSON (seconding the vote of thanks): I am very glad of this opportunity of expressing my admiration for Dr. Tobin's extremely interesting paper. Having worked on part of the same field, I am the better able to appreciate Dr. Tobin's skill and finesse in handling a subject which bristles with difficulties on all sides. I am only sorry not to have been able to give the paper the careful study it so obviously deserves, and must apologize if some of my remarks appear to be

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based on hasty reflections. I am sure that the paper will provide food for thought for some time to come, and that future workers in this field will be very much in his debt.

I will begin by commenting on some of the assumptions implicit in Dr. Tobin's basic demand function (1). At first sight one feels rather startled at the author's boldness; for it is assumed that all the demand elasticities are constant with respect to *all* the variables included in the model. The income elasticity of demand, for instance, is assumed to be the same not only at all levels of income but also for all sizes of family. This assumption is not borne out, at any rate by my own study of pre-war budgets of British working-class families (*J.R.S.S.*, Vol. CXII, 1949, Part IV), where the income elasticity of demand for food was found to vary, for different levels of income and different sizes of family, between 0·3 and 0·9.

Another and probably more vulnerable assumption is that variations in expenditure with respect to the composition and size of the family can be accounted for simply by introducing n (the number of persons in the family) as one of the variables. In the past the numbers have sometimes been adjusted for differences in age and sex by means of equivalence scales and expressed in terms of the equivalent number of adult males. This method has been criticized for not conforming to family expenditure habits. But Dr. Tobin goes even further in using the simple numbers, regardless of age, sex, or of how many members of the family are at work. Further, the assumption that elasticity with respect to size does not depend either on size—that expenditure would show the same change whether the number of persons increased from 2 to 3 or from 4 to 6—or on the level of income is hard to accept. The pre-war working-class budgets for this country reveal the following discrete values of δ (elasticity of demand for food with respect to family size) for different levels of income and size of family:

Number of children increased from—	*Values of δ at total weekly expenditure of—*		
	50*s.* 0*d.*	72*s.* 8*d.*	100*s.* 0*d.*
0 to 1	0·04	0·19	0·19
1 to 2	0·18	0·10	0·10

These figures show only moderate variability, but it must be remembered that they relate to a homogeneous group of families, all of them working-class families with two adults (one of either sex), of whom only one is at work, varying numbers of children and no other person. Since expenditure on food is likely to increase, but not by much, as the size of family increases, income being constant, the values of δ for these families are likely to be small and positive, and the range of possible values is limited. But higher up the income scale families will have savings to draw on and we are likely to find a systematic connection between δ and the level of income.

There are also some interesting problems connected with the form of function (1). Dr. Tobin admits that the use of this function for all consumer goods and savings would be inconsistent with the identity between disposable family income and total expenditure plus savings. I would suggest that the conditions implicit in this identity should form an important part of any generalized description of family expenditure. It is very useful to have an anchor of this kind when working with sets of figures which, at best, are only estimates, and not always of the relevant categories. In any work which covers the whole field of expenditure it provides, as Mr. Marris has found, a valuable check on the consistency of the estimated elasticities. It is, however, easier to ensure consistency if the functions for different commodities all have the same general form. Dr. Tobin's demand function for food implies a different type of function for, at least, some of the remaining items of expenditure. The complications thus introduced would detract from the simplicity which seems to be the great merit of his model.

Dr. Tobin also refers to what he calls the "homogeneity postulate." This appears to be the same as what might be termed the assumption of rational consumer's behaviour, namely, that the consumer does not suffer from "money illusion," and that his demand is unaffected if his income and all prices simultaneously rise (or fall) in the same proportion. This hypothesis relates to income and prices at a single date, and seems to imply, using Dr. Tobin's notation, that:

$$\alpha_1 + \beta_1 + \gamma_1 = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (i)$$

Dr. Tobin interprets his "homogeneity postulate" as implying that:

$$\alpha_1 + \alpha_2 + \beta_1 + \gamma_1 = 0$$

(subscripts 1 and 2 referring to the current year and the previous year respectively).

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But, if they were discussing the same hypothesis, the inclusion in this expression of α_2 (elasticity of demand with respect to previous year's income) would appear to be incorrect.

If the assumption of rational consumer's behaviour applied to income and prices in the previous year, the inclusion in the demand function of previous year's income would have to be accompanied by previous year's prices (P_{t-1} and Q_{t-1}) with corresponding elasticities (β_2 and γ_2) and a second condition would be obtained, viz.:

$$\alpha_2 + \beta_2 + \gamma_2 = 0 \qquad . \quad . \quad . \quad . \quad . \quad . \quad \text{(ii)}$$

If people behave in accordance with the hypothesis, the inclusion of previous year's income without previous year's prices implies that Y_{t-1} is used as a measure of "real," not merely of money, income. If this reasoning were correct, it affected the test given at the end of Section 3.2 of the paper.

The most interesting part of Dr. Tobin's paper is his attempt to combine two sets of evidence: family budgets and time series. The translation of the family demand function into an aggregate demand function depends on the various assumptions discussed above, and on the further assumption of a constant distribution of incomes, as defined by the Lorenz curve. It may be reasonable to assume constancy of the Lorenz curve in the United States for the period included in the analysis. But the assumption will not hold good for the United Kingdom, certainly not for a period which includes the last war.

Although several of Dr. Tobin's assumptions can be criticized for being unrealistic, it is useful and, indeed, even necessary, in pioneering work of this kind, to start by using a good many simplifying assumptions. The possibilities of modifying some of these assumptions can quite properly be considered at a later stage. Moreover, the data that are at present available are hardly adequate to support a more elaborate model. One of the most important lessons, in fact, of the paper is the need to extend and improve the basic statistical data; and, in particular, to have more frequent family budget inquiries.

I should like to comment briefly on a few other points. Dr. Tobin attempts to test the significance between two regression coefficients in section 1.4.1.3, although, as he points out, no valid error can be obtained, since only grouped data are available. In the circumstances I think that very little weight can be attached to the result of this "test."

As Dr. Tobin would probably also agree, the method applied in Section 3.5 does not give a conclusive answer to the problem of serial correlation. The fact that two methods produce consistent results does not prove that his conclusions are unaffected by this particular difficulty.

Section 3.2 gives the results of fitting a regression equation to 4 variables, on the assumption that errors are concentrated in one of them (log P_t). Different results would have been obtained if it had been assumed that errors were concentrated in any of the other variables. Calculations which I have made on different assumptions produce the following approximate values for the demand function parameters (ignoring the case where errors are concentrated in log Qt).

	Errors concentrated in:		
	log S_t	log Y'_t	log P_t
α_2	·20	·64	·12
β	−·36	−·2	−·52
γ	−·15	−·33	−·02

The last column of figures does not quite agree with Dr. Tobin's figures, because I have assumed $\alpha = \cdot 56$ exactly, whereas Dr. Tobin worked with a valu to five places of decimals. It is obvious that very different results can be obtained, according to the assumption made; and, even though the middle column of figures is clearly absurd, one is hardly justified in pinning one's faith to one set of results alone.

Having worked on family budgets, I am glad to find, in section 3.3, that they provide more reliable estimates of income elasticities than the time series.

Mr. R. L. MARRIS spoke as one whose job it was to try to make practical use of the work of men like Dr. Tobin, and he welcomed the paper from that point of view. This meant, however, that not only was he not qualified to make strictly technical comments but that he possessed a vested interest in trying to push research workers farther and faster than they thought it safe at this stage to go. He apologized for this.

He was particularly interested in the prospects of obtaining a similar equation for the United Kingdom. The significance of the paper from this point of view was that it developed an equation

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for food as a whole whereas in this country in the past, work had had to be concentrated on individual items. An equation for all food was of vital importance in the U.K., since with imports largely consisting of food and raw materials (and raw material requirements for a given national income being partly determined by technical factors), the demand equation for food was fundamental in deciding what was necessary to reconcile balance of payments of equilibrium with full employment. The great difficulty in this country—if an equation valid for the post-war period was to be produced—was that pre-war time series would have to be used since it would be some years before any post-war series would be long enough. It would be necessary, therefore, to allow for the known discontinuous change in the distribution of incomes which had taken place during the war. This apparently could only be done if budget data were used which gave a distribution of families by this year's income and expenditure and last year's, providing the assumption of a lag in expenditure were to be maintained. This information was not available in the United States budget data and as a result Dr. Tobin had been forced to make awkward approximations. The implication was that information of this type should be considered an essential requirement of any budgets that were to be taken in the future. In any case the existing budgets—those taken by the Ministry of Labour for the working classes and the Massey budgets for the middle classes just before the war—were not very satisfactory since the working class budgets excluded the unemployed and the middle class budgets were based only on a sample of civil servants and others whose expenditure habits might not be very representative. If, however, an attempt were made to superimpose post-war budgets on pre-war time series (and this would involve the difficult assumption that the elasticities had not changed) there would still be the difficulty of obtaining a pre-war time series for food consumption as a whole. He thought some attempt might be made by taking an index of the volume of food imports from the Trade and Navigation Accounts and adding this, with appropriate weights, to some index which it should be possible to construct of the home output of U.K. agriculture.

He supported Mr. Nicholson in what he had said about consistency. This was particularly important in practical use since applications nearly always had to be made in conjunction with estimates of other types of expenditure. An estimate or forecast was usually part of an aggregate of estimates of some kind, and nearly always had to be reconcilable with a figure of total income. He knew there was the difficulty that a good fit could only be obtained if all the relevant social variables were taken into account. For instance, Dr. Tobin would no doubt say that the existing stock of consumers' durables should be treated as a variable. But to say this was not to avoid the problem. Dr. Tobin had already implicitly assumed that family size was a factor affecting non-food consumption and, similarly, the stock of durables would on this basis become a factor affecting food consumption. He wondered if it would be possible to delimit a number of "general" economic and social variables which could be taken as a standard list to apply to all commodities and to avoid using special variables for particular commodities. This might reduce the quality of the fit in individual cases but might increase the value of the results by increasing their generality. There would be no objection of course to finding modified forms with a larger number of variables in individual cases for use when consistency was not required, i.e. where the application was concerned only with that commodity.

The problem of consistency arose in acute form where a lag was assumed. Dr. Tobin seemed to be saying that when family income went down people cut down first on non-food expenditure and later increased this and adjusted downwards their food expenditure. This did not seem *a priori* either particularly likely or unlikely, but he suspected the truth was that there was a lag in all consumption expenditure and the whole brunt of the initial adjustment fell on savings. This result would, of course, be obtained if a large number of families reacted to a reduction of income by dissaving which could not be continued. This seemed *a priori* likely and could be tested by examination of the U.S. data.

He wondered whether some of these questions could be looked into in the following manner. From the data that Dr. Tobin had used it must be possible to derive a time series of all non-food expenditure plus savings. A distribution of families by income and non-food expenditure could also be obtained. From these data an equation of similar type for non-food expenditure could be obtained by exactly the same methods as Dr. Tobin had used for food—if for the moment one were content with the same set of variables. There also existed a residual equation for non-food expenditure, not derived from any data, implied in Dr. Tobin's equation for food. This latter would be bound to be different from that derived by the method he had just suggested because, as had already been discussed, the mathematical form was such as to make consistency impossible. But it would be interesting to see how different they were, how much loss of accuracy appeared to have occurred as a result of using this mathematical form and how this loss would compare with the loss which might be experienced by using a limited "general" list of variables. For instance, how did it compare with the loss if the family size variable were dropped?

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Mr. L. G. K. STARKE said that, although on matters of economic analysis he could speak only as a layman, it seemed to him difficult to justify the assumption that the income-elasticity of food consumption was constant throughout the very wide range of incomes covered by the family budget data. One's physical capacity for food must have a limit, and there must be some limit also to the extent to which food expenditure could be increased by purchase of the most luxurious and expensive types of food. He would therefore expect the formula connecting food expenditure with income to be asymptotic.

If some such formula were adopted it might well be that the relationship would not lend itself to analysis by the standard methods of multiple regression; but it seemed to him that one ought not to ignore *a priori* considerations merely for the sake of expediency, i.e. in order to bring the problem within the range of normal technique.

The position in regard to the time series was different. The national *per capita* income was not likely to vary sufficiently—even over a considerable span of years—to vitiate the assumption of a constant income-elasticity for *per capita* food expenditure. But in view of what he (the speaker) had just said, he did wonder whether, despite the reasons given in the paper, the author was right in discarding the income-elasticity parameter derived from the time-series themselves in favour of the parameter derived from the budget study.

He hoped Dr. Tobin would accept these tentative remarks primarily as evidence of the interest and enjoyment with which a layman had read his paper. Finally, he wondered whether the time had now come when the Ministry of Food could introduce a little variety into the statistical diet by providing some data on food expenditure in relation to income as well as over-all consumption levels in terms of the eternal calorie.

Mr. K. S. LOMAX said he was sure that any points he might raise would clarify themselves on a closer reading of Dr. Tobin's most interesting and valuable paper on an absorbing subject—a subject of great importance both to the economist, who must attempt to measure the concepts he deals with in his economic theory, and to the statistician who would be keenly interested in the problems of fitting models to data—particularly the simultaneous fitting of demand and supply functions.

The first point he would raise concerned the scope of the paper. Was there not some danger in treating food as a single commodity? The demand functions for different types of food surely must vary quite a lot. Indeed, at one point, Section 1.4.1.3, Dr. Tobin stated that "the increase in urban expenditure for food as income rises represents a shift to higher-quality foods more than an increase in total intake," which surely implies that some of the lower quality foods are probably inferior goods. Yet Dr. Tobin's income elasticities of demand are all positive.

On the purely statistical or methodological side he (the speaker) must confess a certain amount of confusion.

The agreement between single equation least squares values and maximum likelihood estimates in the case of the pair of demand and supply equations in the reduced form and not in the original form seemed logically dissatisfying.

The supply equation introduced in Section 3.4 was a very simple one. Had Dr. Tobin tried the effect of introducing other variables, say agricultural costs of production, into the supply equation? And then again, would it not be more realistic, in the case of food or of agricultural products, to introduce time lags into the supply equation. That is, relate supply in period t to price in period $(t - 1)$?

Thirdly, in view of the dangers of collinearity, particularly, mentioned by Dr. Tobin in Section 3.3, but for general reasons as well, would it not have been desirable to test, by one of the tests of significance which had been suggested, how many structural relationships the data did, in fact, contain?

Finally, might it not be that the increasing share of consumer income devoted to food expenditure, referred to as a mystery by Dr. Tobin in Section 3.6, could be explained on the basis of a shift in the distribution of income?

Mr. C. F. CARTER said that Dr. Tobin's paper was very valuable and he hoped this type of work would increase in volume as time went on. He was still a little worried about n, the number of persons in the family. This number was a curious variable to have in the regression equation, giving rise to many problems including its discontinuity, and the decision to count children as equal to adults. It was presumably reflected in an obscure way by Y_t, the disposable family income for the year, which depended on the number of wage-earners in the family. On the other hand, the number of children might be related to the income of the family. He suggested that some correction for family size might be made to the data before the main regression analysis was

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undertaken. He was, incidentally, surprised to learn that it was possible to assume average family size as constant over so long a period.

There were one or two other points which might perhaps be made clearer in the paper, not for themselves but for future generations who would consult the *Journal* of the Society in order to use these results in practical work. For instance, "quantity" of food presumably meant value at constant prices, and not caloric content: food appeared in this case to exclude drink: and it would be useful to have a record of how the families in the U.S. budget studies were chosen. It might be possible to get more data on the whole subject of the paper by studies of the same group of families over a period of time, and he hoped that this, and other work on the lines laid out by Dr. Tobin, would be undertaken.

Professor J. H. RICHARDSON joined in expressing appreciation to Dr. Tobin for devising the ingenious method used in the Paper, and for obtaining such interesting results. This was another illustration of an investigation in which the delicate mathemtical technique was far ahead of the quality of the data available. It would be valuable if studies of this kind could be made in a number of countries, but in Great Britain it would be a long time before the method could be used with any hope of reliable results. They had had in Great Britain a period of rationing, which precluded use of the time series. There had also been the effects of changes in habits of consumption, price control, subsidies, and of changes in the distribution of income.

With regard to the variables, although the data were at present inadequate in relation to the mathematical techniques used, he would like to suggest that in future investigations variations in the size and composition of the family should be adjusted by the method devised by Quetelet and developed by others to reduce the food consumption of children of different ages to terms of a common adult unit. Consideration might also be given, especially in countries with population trends similar to those in Britain, to the relative food consumption of adults in the prime of life and of elderly retired people. Few data were available about the food consumption of aged people, and if investigations showed their food consumption to be considerably less than that of younger adults an appropriate allowance could be made. This refinement would probably be unnecessary for the data for the United States used by Dr. Tobin.

He, too, was doubtful about the desirability of treating food as a single commodity, especially as there were considerable differences in the food consumption habits of different sections of the community. Better qualities of food were consumed by the higher than by the lower income groups. Different components of the food group were in effect different commodities from the point of view of demand functions.

He had been specially interested in the differences in food consumption between the rural and urban populations of the United States, and it seemed to him that if international comparisons were made it was likely that food consumption in agricultural countries would, other things being equal, be higher than in industrial countries. One would expect to find many conclusions of that kind as this pioneer work was extended to more and more countries.

Dr. TOBIN (in reply):

1. *The Time Series for Food Consumption*

Mr. Stone has quite correctly emphasized the conceptual difference between food consumption measured in dollars in budget data and food consumption measured over time by the B.A.E. price-weighted index of physical quantities. This difference has much more serious effects on estimates of income elasticity than I had anticipated. The discrepancy between analyses (3) and (10) in Mr. Stone's table shows the effects on estimates derived without restriction from time series. Evidently a similar discrepancy arises in estimates from budget data. I have recently received, unfortunately only after the preparation and reading of my paper, Miscellaneous Publication 691 of the U.S. Department of Agriculture, *Consumption of Food in the United States, 1909–48* (Washington, 1949). (This publication provides for the first time a complete explanation of the B.A.E. index.) Table 50 (p. 143) of this report is an attempt to measure food consumption of families at various income levels not in dollars but by the same weighted index of physical quantities used to measure national *per capita* food consumption over time. These estimates are extremely rough (see p. 141 of the report), and they leave out of account the most elastic component of food demand, consumption away from home. But they indicate a much lower income-elasticity—in the neighbourhood of 0·2—than is obtained from budget data when consumption is measured in dollars. In the light of this information I have, of course, to withdraw my objections to the results of analyses (3) and (4) of Mr. Stone's compilation. The values of α in those regressions are not inconsistent with budget data when the same measure of food

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consumption is used. The time series used in the "Tobin-Stone" analyses, however imperfect, is conceptually the appropriate one to use in conjunction with my analysis of budget data.

2. *Lags and the "Homogeneity Postulate"*

Concerning my use of lagged income as a variable in the demand function, Mr. Nicholson has, it seems to me, raised two logically distinct questions. The first is: how is the "homogeneity postulate" to be interpreted in the case of a dynamic demand function? The second is: does it make sense to include the lagged value of one variable, here money income, and not the lagged values of others, here prices?

The theory of consumer choice, on which the homogeneity condition is based, is a static theory. To apply it, we must convert our demand function from a dynamic to a static function. In the present case, this means simply that y_{t-1} is set equal to y_t. Then my equation (1) becomes

$$c = k\, y^{\alpha_1 + \alpha_2} P^{\beta} Q^{t}$$

Imagine two situations in both of which previous income is equal to current income. In the second situation, income and prices are double their values in the first situation. "Rational" behaviour requires demand to be unchanged. This requirement is simply my equation (2), which Mr. Nicholson has criticized. According to his version of the theory (equation (i)) demand would not be the same in the two situations.

Since the theory of rational consumer behaviour assumes static conditions, it places no restrictions on the manner of introducing lags. It provides no justification for Mr. Nicholson's equations (i) and (ii). If lagged prices as well as lagged income are introduced into the demand function, the only requirement which the theory places on their elasticities is the one found by assuming equality of the lagged and current values of all variables, namely:

$$\alpha_1 + \alpha_2 + \beta_1 + \beta_2 + \gamma_1 + \gamma_2 = 0.$$

The second question is, therefore, empirical rather than theoretical. It may be implausible to say, as my demand function does, that consumers will adjust expenditure more rapidly to a rise (or fall) of prices than to an equivalent fall (or rise) in money income. But it involves no contradiction of the "homogeneity postulate," which says only that the eventual amounts of adjustment in the two cases must be the same and is silent concerning the relative speeds of adjustment. I agree with Mr. Nicholson's preference for a symmetrical treatment of lags. The variable we want, in order to embody the hypothesis that consumption habits are "sticky" is not y_{t-1}, or any combination of y_{t-1} and lagged prices. It is c_{t-1} and perhaps, in addition, c_{t-2}, c_{t-3}; . . . . That is, the evidence cited in my section 1.2 can be interpreted as showing that, other things being equal, the current consumption of families is larger the greater was their past *consumption*. Since in a budget study sample past income and past consumption are doubtless highly correlated, this interpretation squares with the observations (Fig. 1) as well as the interpretation I gave in section 1.2. However, an autoregressive family demand function presents formidable difficulties both in aggregation and in estimation of parameters from aggregate time series.

Mr. Marris's conjecture that, given current income, consumption expenditure as a whole is related positively, and saving negatively, to past income is confirmed by United States budget data (Mack, 1948).

3. *The Form of the Function*

Tractable formulae seldom do justice to the full complexity of human behaviour; I can only agree with Mr. Nicholson and Mr. Starke that, in fact, the various elasticities probably are not constant but depend on the values of the variables—and on many other things, too. (However, Mr. Nicholson's figures for δ scarcely support his complaint.)

Mr. Marris and Mr. Nicholson also criticize the form of the function because it cannot be used exhaustively without violating the identity of income and consumption plus saving.

The particular function adopted to display an economic relationship is an approximation dictated by statistical convenience. Economic theory does not tell us what functional form its relationships take. It certainly does not tell us that all consumer demand functions are of the same form. I doubt that my critics would be better satisfied by a simple linear function; the marginal propensity to consume food falls with income (whether or not, as Mr. Starke suggests, it approaches zero at a finite level of food consumption). If not, they are asking for more parameters, whose estimation would increase the statistical burden on a limited number of budget and time series observations. Additional parameters would also complicate the problem of aggrega-

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tion and the comparison of parameter estimates from budget studies of varying detail. In view of these practical requirements of the inquiry, I believe the function I used was the most suitable. Unfortunately we lack any objective means of judging whether simplifications imposed by such practical requirements are over-simplifications or not.

I consider it an advantage of the method I advocated and attempted to illustrate that it calls attention to simplifying assumptions which are rarely apparent but no less necessary in demand analysis employing only aggregate time series.

4. *The Treatment of Family Size*

I agree that some scale of equivalent adults would provide a better measure of family size than number of heads. Unfortunately the budget data which I used did not permit the application of such a scale. I do not believe, however, that the estimate of income-elasticity, which was my main objective in using budget data, would be greatly changed. For the 1935–36 survey it is possible to relate average food consumption per equivalent adult to average income per equivalent adult. This relationship gives very much the same income elasticity as I have obtained.

I do not understand Mr. Carter's concern over the discontinuity of the family size variable and I should have thought that difficulties due to the possible relationships Mr. Carter mentions between family income and size were dodged by the use of observations classified by both variables.

5. *Other Points*

I am sorry to have left doubt concerning the other points which Mr. Carter has raised. "Quantity" of food, in budget data, does mean value at constant prices, and it *in*cludes drink. The methods of selection of families for the various budget studies are described in the sources I have cited, and I do not see any gain in repeating those descriptions.

I agree with Mr. Lomax that individual foods have widely varying income-elasticities, some of which are probably negative. But I fail to see why this is a reason for surprise that my "income elasticities of demand [which refer to food as a whole and not to individual foods] are all positive."

The supply equation in section 3.4 is, as Mr. Lomax says, extremely simple. But Mr. Lomax appears to have overlooked the fact that I am taking production as a predetermined variable and considering whether the share of production going to the home market is sensitive to current prices.

In view of Fig. 8, I doubt that the high post-war expenditure on food can, as Mr. Lomax suggests, be attributed to a change in income distribution.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Iftikhar Ali.
Alexander Crystal.
Raymond Charles Curnow.
Thomas Richardson Ellison.
Royston Sandford Gander.
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Sampling for The Social Survey

By P. G. Gray and T. Corlett

[Read before the Royal Statistical Society February 22nd, 1950, The President, Sir Geoffrey Heyworth, in the Chair]

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(1) INTRODUCTION

THIS paper sets out to record the experience of The Social Survey in sampling human populations during the last four years; the earlier experience of the Survey has already been reported in a paper presented to this Society by Box and Thomas in May, 1944. The paper is not intended to be a discussion of modern developments in the theory of sampling; for a detailed treatment of the theoretical considerations involved we would refer members to the recent book, *Sampling Methods for Censuses and Surveys*, by Yates (1); and though we will give a brief statement of the theoretical basis of our sampling procedures, our main object is to describe in some detail the methods which we have used, and to discuss in the light of this experience some of the practical problems which face the sampler in this country.

Before turning to consider these methods we must give a brief outline of the scope and nature of the Survey's work. A crude measure of the "output" of The Social Survey during the four years under consideration is the number of surveys completed and the number of interviews made; these details are set out in the following table.

TABLE 1

Year	*Number of surveys*	*Number of interviews*
1946	24	64,000
1947	26	93,000
1948	54	107,000
1949	36	110,000
Total	140	374,000

It is clear from the figures of "output" alone that the administrative planning of a particular survey cannot be considered entirely on its own, since each survey must fit into a general programme often involving two, and sometimes three, surveys in the field at a given time.

Some idea of the wide variety of subjects covered by these surveys can be got from the table in the Appendix, in which are set out some details of over a hundred sample surveys. This list is by no means exhaustive, since there is a considerable number of surveys the results of which have not yet been published, and to which it is not possible to refer. Many of these subjects were in themselves very complex, involving the use of complex questionnaires; in many cases a single questionnaire would cover as many as 40 related attributes or variates (the study of attributes has so far predominated), and it was rarely possible for the research officer to fix on any particular one of these as of overriding importance from the point of view of sample design.

The variety of subjects to be studied has inevitably involved the sampling of a great variety of populations, as a glance down the central column of the table in the Appendix will show. These populations can, however, be classified into four broad groups, and in Table 2 below are given the proportion of the Survey's work, in terms both of interviews and of samples, which has been concerned with each group. It will be noted that the total number of separate samples designed during the period (186) exceeds the total number of surveys (140) as given in Table 1; the reason is that 16 per cent. of the surveys conducted during the period each required samples of more than one population.

It will be noted that whereas samples of the general adult civilian population or of particular age- or sex-groups of it accounted for over 80 per cent. of the interviews done in this period, they formed only slightly more than a half of the samples; the heterogeneous "other populations" on the other hand accounted for only 10 per cent. of interviews but over 30 per cent. of the samples which had to be designed.

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TABLE 2

Type of population studied	*Interviews*		*Separate samples*	
	%		%	
Adult civilians—general	74	81	46	53
„ „ particular age or sex groups	7		7	
Households or housewives	9		16	
Other populations	10		31	
All types of population	100 (374,000)		100 (186)	

The totals given at the bottom of Table 2 show that the mean size of all samples used was about 2,000, and in fact almost exactly half of them were of this size or greater. Two of the largest samples were those used in the "Education and Employment Survey," which had a sample of 10,000 individuals, and the "Water Heating Survey," which had one of 6,000 households.* The full size-distribution is given in Table 3.

TABLE 3

Size of sample	*Proportion of samples*	
	%	
5,000 and over	2	
4,000 „	6	48
3,000 „	25	
2,000 „	15	
1,000 „	15	
500 „	17	52
Under 500	20	
All sizes of sample	100 (186)	

It will be noticed that as many as 20 per cent. of the samples were of under 500.

One important trend in the Survey's work during the period has been the steady decline in the use of "quota" samples and a corresponding increase in the use of random sampling procedures. Whereas in 1946 "quota" samples accounted for 26 per cent. of interviews made, by 1948 this proportion had dropped to 3 per cent., and in 1949 this method was not used at all except in a few pilot inquiries and one small survey.

One important consideration which has a bearing upon the form and scope of the sample designs which can be used is the nature of the field organization available to carry them out. This must inevitably affect to some extent the particular forms of sample design that can be used. Thus before turning to the sampling methods employed, it is necessary to consider briefly the administrative organization of the Survey, with particular reference to the field organization.

(2) THE ORGANIZATION OF THE SOCIAL SURVEY

The responsibility for each survey undertaken rests with one Research Officer at Headquarters. Assisted at Headquarters by the Sampling Section, the Field Service Section and the Coding, Machining and Computing Sections, he is in charge of that particular survey from the time of the initial discussions with the Department requesting it until the final report is written.

The interviewing forces number between 250 and 300 part-time investigators, mainly women, recruited locally in such a way as to cover the whole of Great Britain. They are distributed

* The survey of deafness sample (30,000) mentioned in the Appendix consisted, as can be seen from the notes, of 10 samples of 3,000 combined.

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roughly as the population. In charge of these part-time investigators and responsible for their training and supervision are seven full-time Regional Organizers, each with a full-time Assistant.

With 30–50 surveys annually the work would become unmanageable if more than two or three surveys were in the field at one time. Furthermore in many cases information is being sought about behaviour or expenditure during a certain definite period—last week or last month, for example. This makes it necessary to compress the field-work into as short a space of time as possible; generally about two weeks are allotted to each survey. It has been found that in a fortnight an investigator working part-time can be expected to complete on the average from 20 to 30 interviews; as will be seen later, this fact has an important bearing on the sample design.

The responsibility for the design and preparation of the sample for each survey rests with the Sampling Section. As we have no team of samplers, use has to be made of the investigators for drawing samples. Since these investigators have been chosen for their ability to conduct an interview rather than for knowledge of statistical method, it follows that only sampling schemes which can be described in simple instructions can be used. All investigators, however, receive lectures in the elements of sampling theory and practice, and are taught to regard the job of selecting the names and addresses from whatever records are used as of critical importance if the survey is to be a success.

The size and type of sample required for a given survey is decided on after discussions between the Department requesting the survey, the Research Officer and the Sampling Section. When Treasury approval has been obtained, arrangements are immediately made for the drawing of the sample, so that the lists of names and addresses of persons to be interviewed are ready by the time that the final form of the questionnaire has been decided on by the Research Officer and all other preparations have been made.

The Regional Organizers and their Assistants then attend a meeting in London at which the Research Officer briefs them on his questionnaire, and at which a member of the Sampling Section is present to raise any particular points about the sample which may need stressing. During the following week the Regional Organizers hold meetings centrally in their own regions, which are attended by the investigators who will be working on the survey and by the Research Officer.

(3) Some Theoretical Considerations

As we have already stated, this paper does not attempt to deal with sampling theory in any detail. Nevertheless it is necessary before considering the sampling schemes adopted to deal briefly with the requirements of an efficient sample design. At the same time we feel that it may be useful to record in a form in which they can be readily applied the formulae needed for the calculation of the sampling errors in the more important designs later described.

The sample must be such that the population values of the means of the attributes or variates under study can be determined from the data with the necessary degree of accuracy for the minimum cost. If the degree of accuracy is to be calculable from the data some form of random sampling is required, either single- or multi-stage.

(i) *Single-Stage Samples*

In single-stage sampling the persons to be interviewed are selected directly from a list or card-index covering the entire sampling population. Examples from the table in the Appendix are the sample of men certified as suffering from pneumokoniosis and the sample of volunteers to the Royal Air Force.

(*a*) *Simple Random Sample*

This is the simplest type of single-stage sampling, and in its strict application it involves the selection of persons from a list, etc., by means of random numbers. Such a method of selection has in fact never been used by the Survey; a systematic selection is always made. Thus for the sample of men suffering from pneumokoniosis the first name was selected by taking a number at random between 1 and 7 and subsequently every 7th name was selected. Such a selection will be perfectly satisfactory unless the list has a periodic arrangement, that is, if every 7th man is peculiar in some respect—a most unlikely event. Nevertheless for this and other reasons it

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is important to know the exact way in which a list is arranged and how it has been compiled. It may be that the arrangement of the list is such as to give a partial stratification, and if this is so a systematic sample may give slight gains in accuracy over a random sample. If this partial stratification is neglected in calculations of sampling error and the sample is treated as random, the errors will be somewhat overestimated, though the extent of this overestimation is generally small.

For the random sample we have the well-known formulae:

$$\text{Standard Error of } p = \left\{ \frac{p(1-p)}{n} \left(1 - \frac{n}{N}\right) \right\}^{\frac{1}{2}} \quad . \quad . \quad . \quad (1)$$

$$\text{Standard Error of } \bar{y} = \left\{ \frac{\Sigma (y - \bar{y})^2}{(n-1)n} \left(1 - \frac{n}{N}\right) \right\}^{\frac{1}{2}} \quad . \quad . \quad . \quad (2)$$

where the sample consists of n persons chosen at random from a population N, p is the proportion of the sample possessing a certain attribute, y is the value of a variate and $\bar{y}$ the sample estimate of the mean of this variate. In all cases we have met with the term $\left(1 - \frac{n}{N}\right)$ could be taken as unity.

(b) Stratified Random Sample with Uniform Sampling Fraction

If the sampling population can be divided into groups or strata containing similar units and if the same proportion of units is taken from each stratum the sampling errors are in general slightly less than those for a random sample of the same size. Gains in accuracy are more likely to be achieved with variates than with attributes.

Though most attention is usually given to this reason for stratification, in practice other considerations often play a larger part. For instance, it is often useful to stratify the sampling population into groups for which separate analyses of the sample data will be required—for example, by geographical regions. Again, stratification is often adopted involuntarily, as when the records of the population one is sampling are kept separately for each of a number of sub-divisions of that population. If, for example, the population is spread throughout a number of administrative districts, one must sample separately the records for each district and thus automatically stratify the sample. This was the case in the survey in the Lancashire Cotton Towns, where the sampling population was distributed through fifteen towns. Slight gains resulted. The case of drawing a systematic sample from records not randomly arranged is another example of involuntary stratification.

There are two important points in favour of stratification with a uniform sampling fraction as opposed to the stratification with a variable sampling fraction discussed in section (*c*) below. First, stratification with a uniform sampling fraction does not complicate the estimation of means, since no re-weighting of the results is necessary. Secondly, a stratification with uniform sampling fraction which yields gains in accuracy for one of the variables studied will not adversely affect the accuracy of other variables; its effects, if any, are beneficial.

The standard error of the mean of an attribute or variate in a single-stage stratified random sample with uniform sampling fraction is given by—

$$\text{Standard Error of Mean} = \left\{ \frac{\Sigma n_1^2 \sigma_1^2}{(\Sigma n_1)^2} \right\}^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where σ_1 is the standard error of p or $\bar{y}$ for stratum 1, calculated as in equations (1) or (2) above, and n_1 is the number of sampling units taken from stratum 1.

(c) Stratified Random Sample with Variable Sampling Fraction

When a variable sampling fraction is used different proportions of units are taken from different strata. The standard error of the mean of an attribute or variate in a single-stage stratified random sample with a variable sampling fraction is given by—

$$\text{Standard Error of Mean} = \left\{ \frac{\Sigma N_1^2 \sigma_1^2}{(\Sigma N_1)^2} \right\}^{\frac{1}{2}} \quad . \quad . \quad . \quad (4)$$

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where σ_1 is the standard error of p or $\bar{y}$ for stratum 1 calculated as in equations (1) or (2) and N_1 is the total population of stratum 1.

Neyman (2) has shown that for a given sample size and considering one variable only the optimum distribution of the sample among the strata will be obtained by using for the different strata sampling fractions proportionate to the standard deviations of the variable within the strata. The most striking gains in accuracy resulting from such a distribution of the sample usually occur in estimates of the means of variates whose stratum means differ widely.

A more common reason for the use of a variable sampling fraction is the requirement that separate results be given for sub-groups of the population which would be inadequately represented in the sample if a uniform sampling fraction were used. Thus in a sample covering Great Britain separate results may be required for Scotland; as the population of Scotland is only about one-ninth that of England and Wales, without a variable sampling fraction the errors of estimates for Scotland would be approximately three times those of England and Wales.

There are two serious disadvantages that arise from the use of stratification with variable sampling fractions in a single-stage design. First, it leads to the troublesome necessity of re-weighting the sample data before means can be estimated. Secondly, the gain in accuracy for one variable has often to be weighed against a loss in accuracy for others. Neither of these disadvantages exist if a uniform sampling fraction is used.

(ii) *Multi-stage Samples*

In multi-stage sampling a sample of first-stage units is first selected; then within each of the first-stage units a sample of second-stage units is selected and so on for any number of stages. Stratification can be introduced at any or all of these stages, but if sampling errors are to be calculable at least two units must be selected from each of the final strata at each stage of sampling.

In general the addition of another stage of sampling will increase the sampling error for a given size of sample. But for surveys covering widely-scattered populations the cost per completed questionnaire in a multi-stage design is often sufficiently lower than that in a single-stage design to more than compensate for the additional interviews necessary to attain a given degree of accuracy. Furthermore in nation-wide surveys a multi-stage design is often the only one administratively possible.

An additional advantage of the multi-stage design is that a list is only required at the final stage of sampling; this is of considerable importance when lists have to be specially constructed for the survey.

Multi-stage sampling clearly admits of a very wide variety of designs. We shall, however, confine our attention here to two important cases which have formed the basis of the majority of our designs.

Case 1

In this case the first-stage units are districts which have been stratified by a number of factors, one of which is the population of the districts. If from a stratum consisting of M districts, each of population N, m are chosen at random and n individuals are selected at random from each of the chosen districts, then the standard error of the mean of a variate y for such a stratum is given by—

$$\text{Standard Error of Mean} = \left\{ \frac{\left(1 - \frac{m}{M}\right)}{m(m-1)} \sum_m (\bar{y}_1 - \bar{y})^2 + \frac{\left(1 - \frac{n}{N}\right)}{Mmn(n-1)} \sum_m \sum_n (y - \bar{y}_1)^2 \right\}^{\frac{1}{2}} \quad (5)$$

where y is the value of the variate for an individual selected from district 1, and $\bar{y}_1$ is the sample mean for district 1 and $\bar{y} = \frac{1}{m} \sum_m \bar{y}_1$

Similarly the standard error of the proportion of the stratum possessing an attribute is given by—

$$\text{Standard Error of Mean} = \left\{ \frac{\left(1 - \frac{m}{M}\right)}{m(m-1)} \sum_m (p_1 - \bar{p})^2 + \frac{\left(1 - \frac{n}{N}\right)}{Mm(n-1)} \sum_m p_1(1 - p_1) \right\}^{\frac{1}{2}} . \quad (6)$$

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where p_1 is the sample estimate of the proportion for district 1 and $\bar{p} = \frac{1}{m}\Sigma_m p_1$.

In almost all cases which have arisen the factor $\left(1 - \frac{n}{N}\right)$ could be taken as unity.

The equations (5) and (6) above give the standard errors of the means for the individual strata. The standard error for the whole sample can be obtained by combining the stratum values by means of either equations (3) or (4), as appropriate.

It must be noted that in equations (5) and (6) $\bar{y}_1$ and p_1 are sample estimates of district means and thus contain sampling errors. Thus the first term of the two expressions is not, as might appear, the error variance which would arise if all the N second-stage units in each of the selected first-stage units were included in the sample; this would only be so if $\bar{y}_1$ and p_1 were population values. In the case of an attribute the "between district" component of the error variance of a stratum mean is in fact given by the expression—

$$\frac{\left(1 - \frac{m}{M}\right)}{m(m-1)} \Sigma_m (p_1 - \bar{p})^2 - \left(1 - \frac{m}{M}\right) \frac{1}{m^2} \frac{\left(1 - \frac{n}{N}\right)}{(n-1)} \Sigma_m p_1(1 - p_1)$$

and the "within-district" component by—

$$\frac{1}{m^2} \frac{\left(1 - \frac{n}{N}\right)}{(n-1)} \Sigma_m p_1(1 - p_1).$$

The sum of these two expressions gives the total error variance of the stratum mean, and it is this sum which appears inside the main bracket in equation (6).

Case 2

In this case the first-stage units are districts which have been stratified by a number of factors but not by the populations of the districts. If from a stratum consisting of M districts, m districts with populations $N_1, N_2, \ldots, N_m$ are selected with probability proportionate to these populations, and if from each of the selected districts n individuals are selected at random, the standard error of the mean of a variate for such a stratum is given by

$$\text{Standard Error of Mean} = \left\{ \frac{\left(1 - \frac{m}{M}\right)}{m(m-1)} \Sigma_m (\bar{y}_1 - \bar{y})^2 + \frac{1}{Mmn(n-1)} \Sigma_m \left(\frac{N_1}{N}\right) \left(1 - \frac{n}{N_1}\right) \Sigma_n (y - \bar{y}_1)^2 \right\}^{\frac{1}{2}} . \quad (7)$$

where y is the value of the variate for an individual selected from district 1, $\bar{y}_1$ is the sample mean for district 1, $\bar{y} = \frac{1}{m}\Sigma_m \bar{y}_1$ and $\bar{N} = \frac{1}{M}\Sigma_M N_1$.

Similarly the standard error of the mean for the proportion of the stratum possessing an attribute is given by

$$\text{Standard Error of Mean} = \left\{ \frac{\left(1 - \frac{m}{M}\right)}{m(m-1)} \Sigma_m (p_1 - p)^2 + \frac{1}{Mm(n-1)} \Sigma_m \left(\frac{N_1}{N}\right) \left(1 - \frac{n}{N_1}\right) p_1(1 - p_1) \right\}^{\frac{1}{2}} . \quad (8)$$

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where p_1 is the sample estimate of the proportion for district 1, $\bar{p} = \frac{1}{m}\sum_m p_1$, and $N = \frac{1}{M}\sum_M N_1$.

Again the factor $\left(1 - \frac{n}{N}\right)$ can usually be taken as unity. Furthermore when $m = 2$ and $\frac{m}{M} < 0{\cdot}1$ a sufficiently accurate estimate of the overall standard error will usually be obtained by taking the individual stratum standard errors as:

$$\frac{(\bar{y}_1 \sim \bar{y}_2)}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7a)$$

or

$$\frac{(p_1 \sim p_2)}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8a)$$

Then the standard error of the mean for the whole sample is obtained by using either the more exact equations (7) or (8) or the approximate expressions (7*a*) or (8*a*) for each first-stage stratum and combining the results by using equation (4).

A design of this type is of value when a number of useful factors are available for stratifying the districts, and the requirement that there shall be at least two districts per stratum makes it possible only to use a limited number of such factors.

It will be noticed that with a sample of this type, if the same proportion of second-stage units is taken from each stratum then estimates of means for the whole sample can be obtained without reweighting, since all second-stage units have the same overall probability of selection.

(4) THE BASIC SAMPLE DESIGN

Having briefly considered the theoretical considerations involved and bearing in mind the organization at our disposal, we are in a position to consider the sample designs that can be used.

As has been shown, the great majority of surveys undertaken are national ones designed to cover the whole of England and Wales, or the whole of Great Britain, and the majority of these require samples representative of the civilian adult population or households. It is the type of sample design employed for these surveys which will be first considered here.

(i) *Number of Sampling Stages*

If the sample design is to be a national one, it immediately follows that a single-stage sample is out of the question, since the individuals or households to be interviewed would be far too widely scattered for them to be visited within a reasonable time and without prohibitive cost. A multi-stage sample is therefore required, and the obvious choice for first-stage units in this country is "administrative districts"—that is, the county boroughs, boroughs, urban districts and rural districts of England and Wales, and the "large burghs" and counties of Scotland—since for these up-to-date population figures are available, and the majority of records useful for sampling are kept separately for each of these districts.

The existence of these up-to-date records makes it possible to use only two stages, and to dispense with the additional stages used in "area sampling" by the United States Bureau of the Census (3). In such sampling a list of households has to be specially prepared at the penultimate stage, and the expense of this listing makes it necessary to use city blocks rather than the whole city as sampling units for this stage. Since in our case no special listing is required, we are able to use a two-stage sample with administrative districts as the first-stage units, and to sample at a single stage from existing records within the selected districts.

(ii) *Distribution Between Stages*

The number of first-stage units selected and the distribution of interviews between them have to be determined so that the required degree of accuracy can be obtained for the minimum cost. Now an examination of survey costs has shown that the field cost consists of two components,

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one depending on the number of investigators engaged on the survey and the other on the total number of interviews. This first component of cost covers the regional briefing conference and "study time" and the completion of five dummy interviews in the field, these latter not being included in the sample. The second component of cost has been found over the limited range for which figures are available to vary little with size of town and the number of interviews carried out in a town. The greater distance between calls in the larger towns is counterbalanced by the fact that there is probably an investigator living in the large towns, while investigators will probably have to travel to at least a proportion of the smaller districts.

It will clearly be less costly if one investigator in general makes all the interviews required in one district. Since it is necessary when planning a large number of surveys that the field-work on one survey should start and finish at given times throughout the country, it follows that it is preferable to have in general approximately equal numbers of interviews made in the different districts. With such a distribution of interviews the field cost can be represented by

$$pm + qmn,$$

where p and q are constants, m equals the number of districts, and n equals the number of interviews in each district.

With a cost function of this form we will illustrate the variation in accuracy and cost with varying combinations of total sample (mn) and number of interviews per district (n). We will give some curves produced at a time when we were considering increasing the size of the sample of the Survey of Sickness. To simplify the problem we considered a model country consisting of districts of equal populations, and selected a two-stage sample consisting of m districts with n individuals selected in each of these. It can be shown that the standard error of an estimate of a mean is given approximately by

$$\text{Standard Error of Mean} \doteq \left\{ \frac{a}{m} + \frac{b}{mn} \right\}^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad (9)$$

where a and b are constants for a given variable, $\frac{a}{m}$ being the "between-district" and $\frac{b}{mn}$ the "within-district" contributions to the error variance.

It can be shown that for the given variable the optimum distribution of the sample is given when

$$n^2 = \frac{p}{q}\frac{b}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

irrespective of the degree of accuracy required. The actual degree of accuracy obtained will depend on the number of districts taken or—which amounts to the same thing when n is given—the total size of the sample. Clearly this optimum value of n will depend on the ratio of the variability of districts to the variability of individuals within districts in respect of the variable studied. Thus the optimum value of n will be different for different variables. The value of n can thus only be chosen to give optimum conditions for one variable, and it is interesting to see how other variables will be affected.

In preparing the curves we took as our reference-point a sample with 75 districts and 40 persons in each district, that is, a total of 3,000 persons, a distribution which corresponded very approximately to the then existing Survey of Sickness sample for which the ratio [Var (between)/Var (within)] of the "between-district" and "within-district" contributions to the error variance was known for a range of variables.

Figs. 1*a*, 1*b*, 1*c* and 1*d* show four sets of curves. In the first set the value of this ratio at the reference-point or origin is 0·1, while in the fourth set it is 3·0. In each of the four figures the abscissa of the curves gives the relative cost and the ordinate the relative standard error, both being referred to the reference sample of 75 districts with 40 persons in each. There are two sets of curves in each figure, one for constant values of the total sample size (mn), the other for constant values of the number of persons taken within each district (n). The n-curve at the

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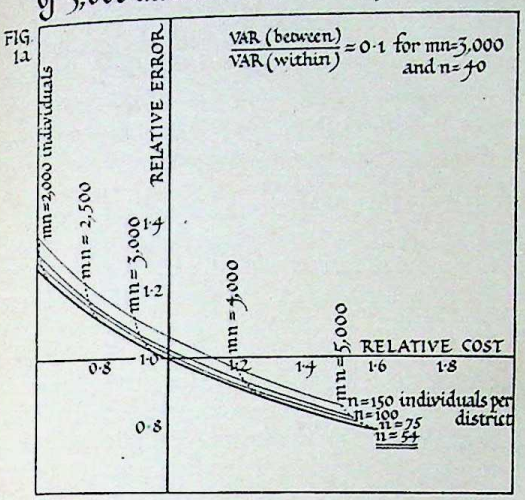
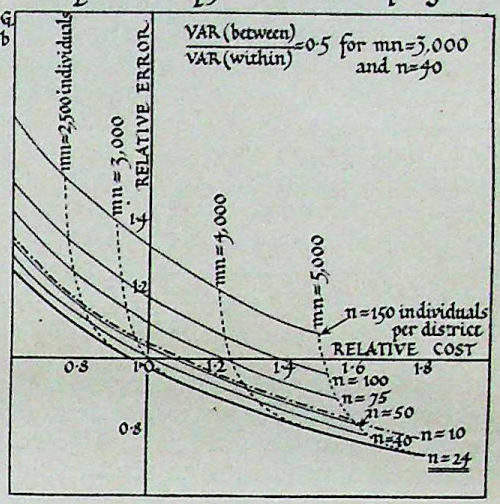
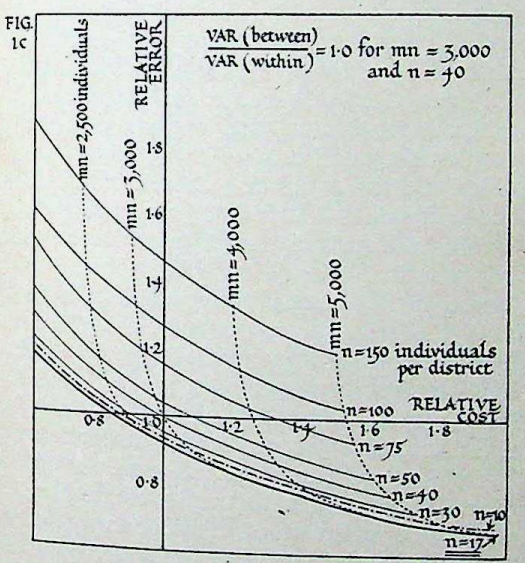
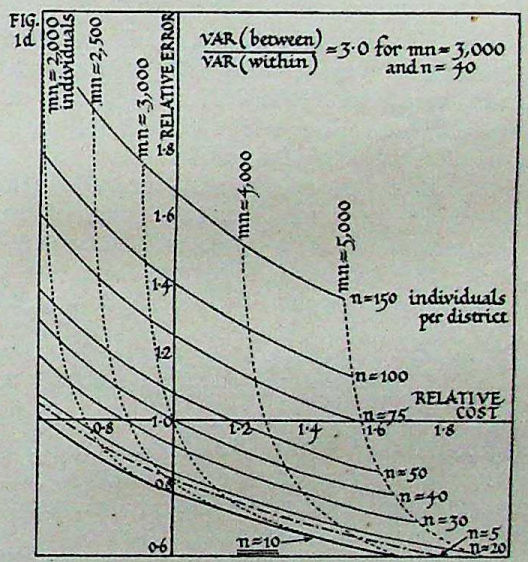
THE VARIATION IN ACCURACY AND COST WITH TOTAL SIZE OF SAMPLE AND THE NUMBER OF INTERVIEWS PER DISTRICT FOR A TWO STAGE SAMPLE OF INDIVIDUALS. {Cost and error are given relative to the values for a sample of 3,000 individuals in which 40 individuals are taken from each of 75 districts sampled}.









extreme left of each of the four figures represents the optimum conditions for that case as determined by equation (10), i.e.

Var(between) / Var(within) at origin	*Optimum n*
0·1	54
0·5	24
1·0	17
3·0	10

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It is possible to use these curves to see whether it would have been possible to obtain a reduction in the sampling errors without increasing cost. Thus for a variable which in the reference sample ($n = 40$, $mn = 3{,}000$) had a ratio of the between-district to within-district variance of 0·5, it can be shown by following down the y-axis from the origin on Fig. 1(*b*) that the standard error for such a variable could be reduced by 3 per cent. by adopting the optimum n-value of 24 and a reduced total sample size, this with no increase in cost.

Generally it will be seen that if an n-value of 30 is adopted we shall be operating very close to optimum conditions in three of the four cases. In the other case [Fig. 1(*d*)], where the ratio of the variance components has the abnormally high value of 3·0, the adoption of an n-value of 30 leads to an error some 20 per cent. greater than the minimum possible for the given cost. It is also possible from these curves to study the variation in cost and accuracy with different combinations of total sample size and number of interviews per district.

Now with the variables taken from the Survey of Sickness we found that the ratio of the error variance components varied from nearly zero to about 2. For example, the ratio of the components of the error variance for the proportion of persons suffering from some illness or injury during the month was 1·6, the standard error itself being 1·3 per cent. Generally the ratio was somewhat lower. It would therefore appear that the general adoption of an n-value of 30 is justified.

In the new design which we adopted and which we shall describe we used the device of selecting districts with probability proportionate to size (4). Although this case represents some departure from the model considered above, it would still appear reasonable to design with 30 interviews per district. Thus for a given size of sample the number of districts is determined.

(iii) *Stratification of First Stage Units*

Once the number of districts to be included in the sample has been decided this determines the number of ways in which the districts can be stratified, since at least one district must be selected from each of the final strata, two if the "between district" variance for each stratum is to be calculable. But before considering what stratifications can be used we have to consider the problem raised by the variation in the size of the first stage units.

Some idea of the considerable variation in size of these districts can be gathered from Table 4, which shows the administrative districts of England and Wales classified by size and by rural and non-rural districts. Greater London has been shown separately, since from the sampling point of view it raises different problems. It will be seen that about 1 per cent. of the districts have large urban populations of 200,000 or more, and that these account between them for some 15 per cent. of the population of England and Wales. As many as 40 per cent. of the districts have urban populations of under 20,000, but these only account for 12 per cent. of the population; 33 per cent. of the districts are rural districts, and they account for 19 per cent. of the population.

It is clear that such a variation in size of the first-stage units cannot be neglected. There are two possibilities: either the districts can be stratified into size groups, or the districts can be selected with probability proportionate to size. The first procedure was adopted in most of our early samples, for at that time we had not discovered very many useful factors of stratification. The latter procedure has been used in our more recent designs, in which the abandoning of size as a factor for stratification has made it possible to use one additional useful factor. We shall confine our attention to the more recent type of design.

Having disposed of the problem raised by the variation in size of the districts, we can now consider possible useful factors of stratification. The usefulness of any factor will clearly vary with the variable for which estimates are required. As stated earlier, in almost every survey we are studying a wide range of perhaps 40 or more variables, and it is rarely possible to say that one of them is of overriding importance. We have for this reason to seek factors for stratification that have proved to be of value with a wide range of variables.

The first division of the administrative districts is made by region. Twelve such regions are used, one of which is Scotland and another Greater London. Regional differences have been found to exist with many of the variables studied. There is, for example, a considerable variation in rent by region. Moreover, it is convenient to stratify the sample into regions corresponding roughly to the administrative regions used by many Government Departments. It is also

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TABLE 4.—*The Administrative Districts of England and Wales*

Type of administrative district	*Number of Districts*		*Population*	
	Number	%	*Population (thousands)*	%
Urban—				
England and Wales (excluding Greater London):				
Population (thousands)				
Over 200	15	1·0	6,498	15·1
150–200	8	0·5	1,370	3·2
100–150	26	1·8	3,105	7·2
80–100	11	0·7	950	2·2
60–80	30	2·0	2,086	4·9
40–60	61	4·2	2,910	6·8
20–40	166	11·3	4,718	11·0
10–20	207	14·1	3,048	7·1
Up to 10	375	25·5	1,944	4·5
Greater London*	94	6·4	8,337	19·4
All Urban	993	67·5	34,966	81·4
All Rural	477	32·5	7,973	18·6
All Districts (England and Wales)	1,470	100·0	42,939	100·0

* Excluding Elstree Rural District which at the end of 1948 had a population of 12,930. The total population of Greater London at this time was thus 8,350 thousands, 19·5 per cent. of the population of England and Wales.

administratively important for the smooth working of the field organization to keep the field-work as evenly distributed as possible over the country.

The second division of administrative districts is into rural and non-rural districts. Considerable differences exist between these two groups in occupations of the population, in amenities of the dwellings and in density of population.

The two stratifications so far described are easily arranged and are generally useful. Further useful factors are not easily found, since the factor must be known for all administrative districts, and must isolate strata showing considerable differences for a range of variables. Analyses of past surveys suggest that the most useful factor or factors should be closely related to the economic or income group of the individual or household and to occupation. The most useful factor that we have found is one based on the rateable value of property in each administrative district.

Tables of the total rateable value of property in each administrative district of England and Wales are published annually by the Ministry of Health (5). However, Local Authorities are bound by the Rating and Valuation Act, 1925, to keep their rating records in three parts—

I—Hereditaments other than industrial and freight-transport hereditaments,
II—Industrial hereditaments,
III—Freight-transport hereditaments—

and we were able to obtain the subdivided totals of each district from the Ministry of Health. Now, although the standards of valuation of property vary throughout the country, it seemed that the ratio of industrial to total rateable value in each district should not be seriously affected by this variation and might be useful as an index of industrialization.

These ratios were tested for correlation with the estimated sample values of a number of variables for the 70 administrative districts included in a national survey of 3,000 individuals. The results showed a marked positive correlation with the important attribute, the percentage

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of people engaged in the manufacturing and mining industries. For urban districts excluding Greater London the correlation coefficient was 0·7 and for rural districts 0·8. It was found that this relationship did not hold for the districts of Greater London. This might be expected since, it is less likely in Greater London that a worker will live in the same administrative district as his place of work. A less marked relationship exists for the percentage of people in the highest economic group. For all urban districts the correlation coefficient was − 0·4, and for rural districts − 0·6. In the case of Greater London it was found that the percentage of persons in the highest economic group showed a fairly close relationship with the rateable value per head of all hereditaments other than freight-transport and industrial (i.e. Part I as mentioned above). The correlation coefficient was 0·7.

Another less useful method of grouping the districts is by smaller zones within the larger regions, the zones being so chosen as to isolate as far as possible different industrial areas. For example the North East Region can be divided into three zones, Zone A being a coalfield, Zone B a woollen textile area and Zone C the remainder of the region.

These four factors—region, type of district (whether urban or rural), industrialization index and zone—are in general all that it is possible to use for stratifying the first stage units in the largest sample commonly employed. With the smaller samples one of these factors has to be abandoned, generally the geographical zoning.

This then constitutes our basic design. The exact procedure involved will become clearer if we consider the selection of districts for a sample of 4,000 individuals in England and Wales as in the current Survey of Sickness: this represents an overall sampling fraction of approximately 1 in 10,000.

(iv) *Illustrative Example*

The 4,000 interviews are first divided out among the eleven regions of England and Wales. For example, the North-Eastern Region with 9·6 per cent. of the population is allocated 382 interviews. These are in turn allocated proportionately, 52 to the rural population of the region and 330 to the non-rural population according to the known proportions for the region.

The 52 rural interviews are divided equally between two rural districts selected from the 31 available with probability proportionate to size. This process is illustrated in Table 5, where the 31 districts are listed in descending order by the industrialization index [column (2)]. The populations are summed cumulatively in column (4), and the appropriate range of numbers

TABLE 5.—*Selection of Rural Districts within North Eastern Region*

Rank	*Name of rural district*	*Industrialization index*	*Population (thousands)*	*Cumulative total of populations (thousands)*	*Range of numbers allocated*
	(1)	(2)	(3)	(4)	(5)
1	Doncaster R.D.	·200	53	53	1–53
2	Wakefield R.D.	·196	18	71	54–71
3	Rotherham R.D.	·150	47	118	72–118
4	Penistone R.D.	·134	7	125	119–125
5	Kiveton Park R.D.	·129	17	142	125–142
..	..	..	..	..	..
..	..	..	..	..	..
17	Goole R.D.	·036	9	398	389–398
..	..	..	..	..	..
..	..	..	..	..	..
30	Bridlington R.D.	·003	9	524	516–524
31	Wetherby R.D.	·002	20	544	525–544
			544		

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is allocated to each district in column (5). A number between 1 and 544 is selected at random, say 123. This number lies within the range [column (5)] of numbers allocated to Penistone R.D. To the randomly chosen number, 123, is added half the total population, i.e. 272, to give a second point, 395, in the total range of numbers. This number, 395, lies within the range for Goole R.D.

We have thus selected two districts with probability proportionate to their populations, using a systematic procedure with a randomly-selected starting-point. It should be noted that this systematic procedure results in a stratification by industrialization index, and should thus give a slight improvement in accuracy of the sample estimates over that given by a purely random procedure. This stratification has, however, to be neglected when the between-district contribution to the sampling error is calculated, and this will in general lead to a slight over-estimation of the sampling error.

We have now decided upon the distribution of the Region's rural allocation of interviews; the urban allocation of 330 interviews must now be dealt with. With the overall sampling fraction of about 1 in 10,000 any large town with a population of about 300,000 or more will itself be entitled to an allocation of about 30 or more interviews. There are four such towns in the North Eastern Region, and their allocations are set out in Table 6.

TABLE 6.—*Large Towns within the North Eastern Region*

Large town	*Population (thousands)*	*Entitlement of interviews*
Sheffield	512	48
Leeds	503	47
Hull	297	28
Bradford	290	27
Total allocation for large towns		150
Remaining urban interviews		180
Total urban allocation		330

The persons interviewed in these four large towns thus form a single-stage stratified sample of the population of the large towns, since they will have been selected after one stage of sampling only. This single-stage sample accounts for 39 per cent. of this Region's allocation. (Nationally there is a sufficient proportion of the population living in such large towns to enable 12 per cent. of a 4,000 sample to be treated in this way.) The slightly higher cost per interview in these large towns is justified by the absence of a between-town contribution to the sampling error.

There still remain 180 interviews of our urban allocation. This suggests the use of three strata containing as nearly as possible equal populations, from each of which two districts will be selected. The urban administrative districts are first listed in descending order by the industrialization index and divided into three strata with ranges of this index, ·150 to ·060, ·059 to ·036, and ·035 to ·001. These ranges are so chosen as to give strata containing approximately equal total populations. For example, the stratum covering the range ·035 to ·001 consists of 28 districts with a total population of 628,000, and receives an allocation of 58 interviews. Two districts are selected from this stratum with probability proportionate to population size in the following way. The districts of the stratum are first rearranged into three groups according to which of three geographical zones of the region they fall into. Zone A roughly covers the area of the South Yorkshire Coalfield, Zone B the Woollen District of the West Riding, and Zone C the remainder of the Region. This re-arrangement of the districts is illustrated in Table 7.

In column (4) the cumulative totals of population are shown for the whole stratum and in column (5) the range of numbers allocated to each district. The two districts, Mexborough U.D. and Harrogate M.B., are selected by using the same procedure as for the rural districts. (Random starting-point = 203; interval = 628 ÷ 2.) This systematic procedure results in a stratification by zone, which cannot however be allowed for in the estimation of the sampling

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TABLE 7.—*Selection of Urban Administrative Districts from a Stratum of the North Eastern Region*

(Stratum range of industrialization index ·001 to ·035)

Rank	*Name of "urban" administrative district*	*Zone*	*Population (thousands)*	*Cumulative total of populations (thousands)*	*Range of numbers allocated*
	(1)	(2)	(3)	(4)	(5)
1	Barnsley C.B.	A	75	75	1–75
..	..		..	..	..
6	Mexborough U.D.		19	214	196–214
..	..		..	..	..
9	Tickhill U.D.		2	230	229–230
10	Wakefield C.B.	B	58	288	231–288
..	..		..	..	..
13	Ilkley U.D.		17	331	315–331
14	Selby U.D.	C	11	342	332–342
..	..		..	..	..
23	Harrogate M.B.		52	554	503–554
..	..		..	..	..
28	Withernsea U.D.		5	628	624–628
			628		

errors; again a slight over-estimation of the sampling error is to be expected. The remaining two urban strata of the Region are similarly rearranged, using the same zones.

Of the remaining 10 regions, 9 are treated in a similar fashion. Greater London, however, is dealt with in a slightly different way. Its allocation of interviews is first divided between three sub-regions of approximately equal populations, South, North-West and North-East London. The districts of each sub-region are then arranged in descending order of rateable value per head of population, that is, the rateable value of all hereditaments in the district other than those classed as industrial or freight-transport. For example, the 34 districts of South London range from £15·01 per head to £6·28 per head. This range is then divided into three strata with ranges £15·01 to £9·88, £9·65 to £8·35 and £8·19 to £6·28, which account for approximately equal populations. Two districts are selected from each stratum with probability proportionate to population size in the manner described above.

This example has served to illustrate the selection of first-stage units (administrative districts) for a national sample, and the determination of the number of second-stage units to be selected in each. The factors of stratification employed at the first stage have been those likely to be of general use. The design is such that the sampling errors of estimates are calculable from the sample data; they can be estimated by using either equations (7) or (8) for strata in which two stages of sampling have been used, and either equations (1) or (2) for those "large town" strata where a single stage has been used. The estimates of errors for the individual strata can then be combined to give an estimate of the overall sampling error by using equation (3). It may be noted that the overall probability of selection is constant for all individuals in the population; consequently no reweighting of component parts of the sample is necessary before estimates of population means can be obtained from the sample data—a fact which is of considerable importance at the computing stage. Furthermore, the approximately equal numbers of interviews in all districts makes the design administratively workable.

Although in the above example we have selected only one set of first-stage units, in practice we should normally select a number of different sets of each of a number of standard sample sizes (for example 4,000, 3,000, 2,000, 1,500, 1,000 and 500) for use as required during the next

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six months. The procedure for selecting further sets of districts for samples of 4,000, for example, can be illustrated by reference to the example given above of the selection of two rural districts from a stratum. In order to select five further pairs of districts from this stratum a twelfth of the total range of sampling numbers (i.e. $544 \div 12 = 45$ approximately) is successively added to each of the numbers (123 and 395) which determined the selection of the original pair. The first of the extra pairs would then be determined by the numbers 168 and 440, and the next pair by 213 and 485, and so on. It will be seen that in the case of the districts to be sampled in two stages the same small town will not appear in more than one set, although a few of the larger towns may appear more than once. Of course, the large towns sampled at one stage only will appear in each set.

It will be gathered from this that we are not in general in favour of the use of one master set of districts. There are a number of reasons for this. It is important for the Survey to maintain a considerable degree of flexibility in its field organization in order to be able to deal in any region with samples covering different numbers of districts, and if necessary with two or more samples at the same time. It does not follow that the same set of towns is never used for more than one survey, but where possible we avoid the frequent use of the same set within a short space of time. Too frequent a use of a given set of districts leads to difficulties which can be illustrated by considering the case of Penistone R.D., one of the districts selected in our example above. It has a population of about 7,000 individuals or about 2,000 households. The interviewing of a sample of 30 individuals or households will affect about 1 in 67 of these households. Twelve such samples in successive months will affect about 1 in 6 households during the year. It is true that by using successive systematic selections from the lists the chance of a given household being revisited can be reduced to less than that which would be involved in successive random selections, but even if no household is revisited the growing intensity of sampling during the period may have the undesirable effect of itself producing changes of opinion in the population.

However, it might appear that with a survey such as the Survey of Sickness, which is repeated every month to show month-by-month changes, a single set of districts should be used. This would mean that the "between-district" contribution to the sampling error could be ignored when making comparisons between months. For certain purposes, however, it is necessary on this survey to combine two successive months' samples to form a single sample; it is clear that greater accuracy will result if two different sets of districts are used. The best solution we have found is to use two sets of districts alternately for the six winter months, changing to two further different sets for the following six months. Thus in any pair of successive months different sets are used, while two groups of three samples in which the same sets are used are available for either season for making comparisons in which the "between-district" component of the error can be neglected.

A number of the basic sampling designs are prepared at six-monthly intervals using the latest estimates of population supplied by the Registrars General. It will be noted that these designs are based on the distribution of the total civilian populations of all ages of the districts; we in fact use these designs for samples of civilian adults and of households. Theoretically their use for such populations requires a reweighting of the results to allow for variation from district to district in the proportion of adults in the civilian population and in the mean size of households. In practice for our range of sample sizes such a correction can be neglected.

The selection of the second-stage units (civilian adults or households) requires the use of lists or other records of the population. The main types of lists available and their uses will now be described.

(5) The Main Records Available And Their Uses

There are three main sets of records available for each administrative district in the country from which samples can be selected either directly or indirectly—the National Register, the Rating Records and the Electoral Registers. We will describe each of these records in some detail, since it is important to know whether their arrangement is such that they can be safely sampled systematically, and whether such a procedure will have the effect of stratifying the sample. We shall follow this with illustrations of how they can be used and the uses we have made of them.

Although we have not ourselves made use of the Electoral Registers on any major enquiry, we include them because they are readily available to unofficial bodies.

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(A) *The National Register*

(i) *Origin*

The National Register of Great Britain and the Isle of Man was first compiled on the basis of an enumeration of the population organized by the Registrars General, and carried out by some 65,000 enumerators on September 29th, 1939. Separate arrangements were made in Northern Ireland, but in the rest of the United Kingdom the normal census procedure was generally followed, individual returns being made on household schedules completed by the head of each household or institution. The enumeration was designed to record in each district all persons in residence in that district whether permanently or temporarily at midnight September 29th–30th.

Thus the Register as first compiled consisted of records of the whole civilian population resident in the United Kingdom and Isle of Man on the day of enumeration. On the basis of these records Identity Cards and Ration Books were issued. The original schedules for each administrative district were kept at a local National Registration Office, where a card was later filed for every civilian inhabitant of the district.

(ii) *Upkeep of the Register*

Changes in the civilian population of a district occur in a number of ways—by births, deaths, call-up or enlistment in the Armed Forces, demobilization, discharge or release from the Armed Forces, and removals to or from another district or the United Kingdom. Each register is kept up-to-date throughout these changes as follows:

Births

A card is made out for the child at the local National Registration Office when application is made for a Ration Book and an Identity Card is issued.

Deaths

Notification is sent via the Central National Registration Office to the local National Registration Office when the death is registered, and the card is then withdrawn from the live register.

Call-up or Enlistment

When a person is called up or enlists in the Armed or Auxiliary Forces or Merchant Navy he surrenders his civilian identity card at the reception unit; when notification reaches the National Registration Office his card is withdrawn from the live register.

Demobilization, Discharge or Release

When a person is demobilized, discharged or released from the Armed Forces, etc., he is issued with a civilian identity card at the office at which he applies for a ration book and a card is made out for him for inclusion in the local register.

Removals

When a person moves from district A to district B, the National Registration Office at B where he applies for re-registration of his ration book makes out a card for him and files it in the register at B. This office then notifies the Central National Registration Office which in turn notifies the local National Registration Office at A and his card is then taken out of the register at A.

If he is proceeding abroad notification is sent to the Central National Registration Office by the air- or sea-port authorities and his card is withdrawn from the live register of the area in which he last resided.

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(iii) *Description of a Register*

The actual register consists of cards measuring 6 in. by 4 in. filed in drawers. The information which is useful for sampling purposes and which is recorded on each card consists of—

Surname and Christian names.
The present address.
Age or date of birth.
Nationality—British or alien.
The National Registration letters and number.

It should be noted that no indication of the person's occupation is given.

The cards are filed in two main sections, an Adult Register and a Children's Register. We shall confine our attention to the Adult Register.

The Adult Register should contain a card for every civilian aged 16 years and over resident in the district. The cards are filed in National Registration code-letter order, from AAAA to ZZZZ, and in number order within a given combination of letters.

The National Registration code-letters and numbers (collectively referred to as "National Registration numbers") issued on Enumeration Day distinguished the administrative district, the enumeration zone within the district and the household in which the person was living on that day. National Registration numbers issued to people newly registering after that day (persons demobilized, etc., from the Forces and new entrants from outside the United Kingdom) distinguished the administrative district in which the person was living at the time of registration. These numbers were distinguishable from those of the original registrants in the district, and also enabled cards relating to demobilized persons to be distinguished from all others. Since the cards of any local register are filed in National Registration number order it will be seen that the register will contain blocks of cards relating to three main groups of people readily distinguishable by their National Registration numbers:

(i) Persons resident in that district on Enumeration Day and still living there, though not necessarily at the same address; these will form the bulk of the register.

(ii) Persons newly registering in the district since Enumeration Day. They will be demobilized persons (distinguishable from any others by their National Registration numbers), persons discharged or released from the Armed Forces and Merchant Navy, and any new entrants from outside the United Kingdom.

(iii) Persons now living in the district who have moved in from elsewhere since Enumeration Day. Cards relating to demobilized persons will be distinguishable from the others.

There will also be a small fourth group of cards bearing four-letter codes beginning with "Y." There are no district codes beginning with "Y"; these cards are the result of a system, discontinued some three years ago, by which persons who lost their identity cards were issued with a new one prefixed by the letter "Y." When a new identity card was issued, the person's card in the register was replaced by a "permanent debit" card bearing the original as well as the new number, and a new card was filed in the "Y"-section of the register, the "permanent debit" card acting as a cross-reference. These "permanent debit" cards are readily distinguishable from the "live" cards in the register.

It will be seen that the National Register provides a "live" and uniformly arranged record of the civilian population of each administrative district of the country, which is extremely useful for population sampling.

The particular uses we have made of this Register can be considered under four main headings, the first and main use being for sampling the adult civilian population.

(*a*) *Samples of the Adult Civilian Population*

It will be remembered that 74 per cent. of the Survey's output of interviews during the last four years was accounted for by samples of this type (Table 2). On particular surveys there are certain minor groups of persons included in the adult portion of the National Register but not distinguishable in it who are not part of the sampling population as defined for the survey—for example, residents in institutions, other than staff. In such cases a sample is taken from the

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whole of the register, and persons not in the sampling population are identified at the interviewing stage and rejected then.

The selection of cards from the register is done by measuring intervals rather than by counting since the numbers involved are so large. This can be done since the cards are of uniform thickness and are neatly arranged in drawers. The total thickness of cards in inches when they are compressed and measured along the top is given approximately by the total civilian population of the district divided by 140. Thus the interval at which cards are to be selected can be determined in advance by dividing this estimate of total thickness by the number of interviews to be made in the district; it is unnecessary to measure the total thickness of cards in the register before the sample is drawn. The interval so determined incorporates a small safety factor to allow for slight local variations, so that rather more than the required number of cards will be drawn; the surplus names and addresses are rejected at random.

If a register is repeatedly sampled in this way at a given interval—as for example, when successive monthly samples are selected from the registers of the "one-stage" large towns for the Survey of Sickness—the danger of the same individuals being included in the sample in successive months is avoided by varying the starting-point of the measurements. It should be noted that several samples required for successive months cannot safely be drawn at the same time since there is considerable movement of the population; we know, for example, that about 7 per cent. of households move in a year. We normally aim to draw such samples about 2 weeks before their use in the field.

When a sample is to be drawn individual instructions are issued to each investigator giving the necessary information relating to the register to be sampled and containing reminders about some of the more important points to be watched. These include such points as the importance of ensuring that all files containing the live register are included in the sampling (some may be in use in another part of the office), and that the correct address is copied from each card. Care is needed on the latter point, since both the present and the previous address are recorded on cards relating to persons who have moved, and two types of cards used in the file have the new and the old addresses in different relative positions. The investigator records the name, present address, date of birth, etc., of each person selected on a standard form provided for the purpose. Two copies are made, one of which is sent to Headquarters.

The systematic selection of the cards introduces a degree of stratification into the sample. The initial arrangement of the register in September, 1939, was such that the cards were fully stratified by enumeration zone and by household. Subsequent changes of address, marriages and entries into and discharges from the Armed Forces have overlaid this original arrangement and have led to further stratification. The most clear-cut stratification at present in the register is that between persons who have served in the Armed Forces and others. The others are also divided into two separate groups, those who originally registered in the district in 1939 and those who have moved into the district since. These three main groups differ in a number of respects; for example, in a sample of 1,500 covering five large towns the proportion of persons aged 65 years and over was *nil* for the ex-service group, about 15 per cent. for the original registrants of the district, and about 9 per cent. for the remaining group. The result of this is that the error variance of the proportion of persons aged 65 and over in the sample would be over-estimated by approximately 5 per cent. if the stratification were neglected and the sample treated as random.

It should be noted here that a proportion of cards of persons reaching the age of 16 are not transferred immediately to the Adult Register. Nationally about half those aged 16 and about a quarter of those aged 17 appear to remain in the Children's Register. It would seem that this arises because, while Identity Cards should be changed at 16, ration books do not have to be changed until 18.

In a national sample of adults taken from the Adult Register in which the variables studied show an appreciable variation with age this small deficiency can be corrected for, if in fact any correction is deemed necessary, by reweighting the results. The problem needs more attention when a sample of only a small age-range starting at 16 is required. In this case the cards missing from the Adult Register can be given their due chance of inclusion by selecting cards at the calculated interval throughout the Children's Register and by rejecting all except those relating to persons aged 16 or over. This type of sample is considered in the next section.

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(b) Samples of Particular Age- and Sex-Groups

A second use of this register is for drawing samples of particular age- and sex-groups of the civilian adult population. An example of this use was the survey "Men and Mining," in which the sample consisted of male civilians in Great Britain aged 16–60, excluding miners. The interval as calculated to yield a sample of the total civilian adult population of the same size for a given register was multiplied by the ratio of the national total of male civilians in the required age-range to the total civilian adult population in the country. Cards were then selected at this reduced interval, and any card drawn that did not fall within the required group was rejected. Miners—not identifiable from the cards—were rejected from the sample at the interviewing stage. It should be noted here that the time-saving method of taking a number of systematic starting-points throughout the register equal to the number required in the sample and of examining successive cards from each point until an eligible person is found would lead to bias. For owing to the stratification of the register described above the proportion of eligible persons will differ considerably in different parts of the register—the ex-service group, for example, will have a smaller proportion of women and old people than the other groups. Thus, if the time-saving procedure were adopted, the ex-service group would be under-represented in the sample.

Samples of any age- and sex-group can be selected by the method used for "Men and Mining," though the procedure becomes somewhat laborious when the group required accounts for only a small proportion of the total age-range.

(c) Samples of Ex-Service Personnel

The register has also been used for obtaining samples of ex-Service personnel. An example of this use is the sample for the "Demand for Campaign Stars and Medals" survey made in October, 1947. The sampling interval is calculated by a method similar to that described in the previous section. In practice it is not then necessary to draw cards from the large section of the register containing cards relating to original registrants in the district. The bulk of the sample will be obtained from the portion of the register relating to persons who registered in the district on their demobilization, but care must be taken to examine cards at the calculated interval throughout the remaining portion of the register containing cards of persons who have moved into the district, since a proportion of these will be demobilized persons.

(d) Samples of Households

While we do not normally use this register for obtaining samples of households, we have found it useful in dealing with a particular type of town-planning survey, where information is required both about households and about the opinions of individuals. In our earliest survey of this type we first obtained a sample of households, and then attempted to interview all the adults within each household about their opinions. This method proved to have serious disadvantages, since it is extremely difficult to interview separately at one visit all the adults in a given household without another member of the household being present at the interview. The answers of the first person interviewed were very liable to influence those of the others, especially when, as often happened, one member of the household could only be approached at a subsequent visit when he would have had opportunity to discuss the subject with other members. Such opportunity for discussion appeared also to lead on occasions to the un-interviewed member deciding to refuse to be interviewed when the investigator returned.

In view of these difficulties we approached the matter in a different way on a later series of surveys of this type. A sample of adult civilians was drawn from the register in the normal way, and these individuals were questioned about their opinions and then asked to supply some factual data about the household of which they formed a part. The fact that only one individual was interviewed in any household disposed of the interviewing difficulties mentioned above, and also of the need to allow for real correlation of opinion between members of the same household; the data in fact related to a normal random sample of individuals. From the point of view of the household data, on the other hand, the sample can be considered as a sample of households in which each household selected had a probability of selection proportionate to the number of its members having cards in the adult register—that is, to the number of its members aged 16 years

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and over. Clearly the data obtained for each household thus required to be re-weighted by $\frac{1}{n}$, where n is the number of persons in the household aged 16 and over. This can be done in several ways. It can obviously be done at the computing stage, although this is very laborious if a large number of cross-analyses is required. There are a number of methods using punched card equipment that can be used, and we have found that the following method has proved useful. The weights to be applied to the different groups, i.e. 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$ . . . are multiplied by 4 to give 4, 2, $\frac{4}{3}$, 1, $\frac{4}{5}$, $\frac{4}{6}$ . . . Then the first group of Hollerith cards is reproduced three times, the second group once, and one-third of the third group selected a trandom is re-produced once. One-fifth of the fifth group is rejected at random, two-sixths of the sixth group, and so on. With the kind of distribution of household sizes likely to be encountered this involves passing some 70 per cent. extra cards through the machines and wasting about 2 per cent. of the material through rejections. The resulting tabulations do not, of course, then need re-weighting.

It is interesting to note that the Americans have found similar interviewing difficulties on attitude surveys when using their "area sampling" methods which lead to a sample of households. In a recent paper (6) Kish states that "in surveys of the attitudes of the adult population, multiple interviews in one household may lead to undesirable interview situations, and there is need for a procedure of selection that will translate a sample of households into a sample of the adult population." He goes on to suggest a procedure by which one adult may be selected at random from the household, and a system of weighting the results to overcome the fact that each person will have thus been selected with a probability proportionate to the number of adults in his household. The procedure may be looked upon as the converse of the method we have used in our town-planning surveys.

While we cannot give illustrations from our unpublished surveys, we can give an interesting example from the Survey of Sickness of the way in which an individual sample can be used to obtain household data.

Table 8 gives the distribution of households by size obtained in three different ways from the same sample.

TABLE 8.—*Household Data Obtained from a Sample of Individuals*

*Total number of persons in household**	*Distribution obtained from a Survey of Sickness sample of individuals†*			(d) *Distribution obtained from a household sample taken from Rating Lists‡*
	(a) *By re-weighting total sample as above*	(b) *By using data from Senior Wage Earners only*	(c) *By using data from Housewives only*	
	%	%	%	%
Two	29·9	27·0	25·6	30·4
Three	28·3	27·9	29·6	27·5
Four	22·0	22·2	21·1	22·7
Five	11·2	13·6	11·7	10·6
Six	4·6	4·6	5·7	4·6
Seven	2·1	2·9	3·0	2·0
Eight	0·9	0·7	1·4	1·0
Nine or more	1·0	1·1	1·9	1·2
All numbers	100·0	100·0	100·0	100·0

* The one-person households have been excluded from this comparison since the household sample (Rating List) excluded hotels, boarding houses, institutions, while the Survey of Sickness sample treats most of this group as one-person households.

† A sample of 3,000 individuals.

‡ A sample of 1,500 households.

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In the Survey of Sickness each individual is asked to state amongst other things—

(i) The total number of persons in the household of which he or she forms a part;
(ii) the number of persons aged 16 years and over in the household;
(iii) whether or not he or she is the "Senior Wage Earner" of the household;
(iv) whether or not he or she is the "Housewife" of the household.

(By our definitions there should be one, but only one, "Senior Wage Earner," and one, but only one, "Housewife" in any household.)

We see first of all from the table that there is good agreement between the re-weighted individual sample distribution (*a*) and that of the household sample (*d*). The distribution (*b*) based on the data obtained from only those of the individual sample who were the "Senior Wage Earners" of their households should, and does, without re-weighting, show reasonable agreement with distribution (*a*). Similarly distribution (*c*) based only on those of the individual sample who were the "Housewives" of their households should agree with distribution (*a*). It does not. The larger households are clearly over-represented. Investigation showed that women other than the one "*mainly* responsible for the housekeeping" of the household (our definition of a "Housewife") had been classified as "Housewife." This error naturally led to an over-representation of the larger households in distribution (*c*).

When distribution (*c*) was compared with distribution (*d*) in the absence of the other distributions it was suggested that the discrepancy arose from a bias in the original sample of individuals. We were happy to be able to demonstrate that this was not the case, and that the problem raised was not one of sampling.

(B) *The Rating Records*

(i) *Purpose*

Since rates are based upon the occupation of land or premises, an essential step before rates can be levied is the valuation and listing of property. For this purpose Great Britain is divided into "rating areas" in charge of "rating authorities," areas which correspond throughout the country with the administrative districts, the "rating authority" for each district being its local government council. It is the duty of each local authority* to have prepared a list of all property in the district; these are the rating records.

The method of keeping the records was to some extent standardized in the 1920's, and certain "rules" were laid down regarding the basic form and content of these records. Since the Scottish rating system differs in many respects from that in force in England and Wales it will be considered separately.

(ii) *Description of Rating Records*

Under Section 58 of the Rating and Valuation Act, 1925, the Minister of Health was given power to "proscribe the form of any valuation list." Orders later made under this Act are summarized below.

(*a*) *England and Wales*†

The orders required that throughout England and Wales the Valuation List of each authority should be divided into three parts as follows:

Part I.—"Hereditaments other than Industrial and Freight Transport Hereditaments"

This is the section containing dwelling property, and in addition many other forms of property not included under Parts II and III—e.g. shops, warehouses, cinemas, theatres, offices, schools, etc.

* Under the Local Government Act, 1948, Part III, Valuation and Rating Procedure, section 33 *et seq.*, valuation of property will be carried out by valuation officers of the Commissioners of Inland Revenue. The first lists so prepared will come into force in April, 1952.

† For England and Wales, excluding the City of London and Metropolitan Boroughs: "The Rating and Valuation Act (Form of Valuation List) Rules, 1932." For the City of London and the Metropolitan Boroughs: "The London (Valuation List) Rules, 1933."

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Part II.—Industrial Hereditaments
These include factories and mines.

Part III.—Freight-Transport Hereditaments
These include railways, canals, docks and road-transport depots.

A provision of the order was that the list should be kept in "parochial sections"; this did not, however, apply to the City of London and the Metropolitan Boroughs.

The order also laid down the procedures for keeping the lists up-to-date. These were as follows:

City of London and Metropolitan Boroughs
A new valuation list is prepared every five years. In addition a supplemental list containing amendments is prepared each year, and a provisional list is kept during the year and incorporated in the supplemental list at the end of the year.

Rest of England and Wales
A valuation list is prepared every five years. This list is currently kept up-to-date by amendments "in ink of a different colour" and by additions at the end of the appropriate parochial section.

(*b*) *Scotland**

In Scotland the "Valuation Roll" corresponds to the Valuation List in England and Wales.

The Order did not specifically require the division of the Roll into three parts as in England and Wales, but it did require that the Roll should distinguish (by a mark or otherwise) lands and heritages which were agricultural, freight-transport or industrial.

A new Valuation Roll is prepared annually.

There thus exists for each administrative district in Great Britain a valuation record detailing all property in the district, each separately rated item being separately listed. These items are known as "hereditaments" in England and Wales and as "heritages" in Scotland; the term "rateable unit" is more convenient for our purpose and will be used henceforward in this paper.

The useful information that can be extracted from the record for any rateable unit is:

(i) The name of the occupier;
(ii) the situation (i.e. address) of the unit;
(iii) a brief description of the unit—e.g. "house," "flat," "shop and dwelling," "house and premises," "offices," etc.;
(iv) the rateable value.

Two points should be noted. First, the name of the occupier is not invariably recorded, and where recorded it may be out of date; it should thus not be relied on except as a guide. Secondly, in rural districts the situation of the property as recorded occasionally consists only of the name of a village, and it then is necessary to seek further information about any particular rateable unit selected, so that it can be easily traced.

This valuation record in its legally prescribed form normally consists of a series of ledgers. But there may also exist a series of "rate books" used for the day-to-day business of the rating office. These will usually contain all the useful information given in the main valuation record, and they may thus be used for sampling purposes as an alternative to the valuation record itself. Local practice varies considerably.

It will be seen that the rating records provide a live record of "rateable units" which can be used as a basis for sampling households.

(iii) *Use for Sampling Households or Housewives*

Some 9 per cent. of our interviews or 16 per cent. of samples during the past four years were accounted for by samples of households or housewives. The Survey's definition of a household is a group of people normally living in the same dwelling and sharing in the same housekeeping unit. Boarders provided with one or more of their meals by the housewife are counted as members

* 'Valuation Roll (Scotland) Order, 1929.'

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of the household, but people living as lodgers in a room in the house, but doing their own housekeeping are treated as separate households. The housewife is the person in any household mainly responsible for the housekeeping; there is one and only one housewife in each household. Thus for sampling purposes samples of households or housewives present the same problem.

It is clear that a sample drawn from the rating records, even if non-dwelling rateable units are excluded, will not constitute a sample of households but one of rateable units of dwelling property, any of which may contain more than one household. The first approach to a sample of households is, however, to obtain a sample of these rateable units of dwelling property.

(*a*) *Selection of a Sample of Dwellings*

We have in practice found it useful to have the sample drawn at a constant interval throughout Part I of the record in England and Wales and throughout the whole of the record in Scotland, all rateable units selected at the given interval being recorded, whether dwelling property or not. This is convenient, since it simplifies the sampling procedure and also provides useful information about non-dwelling property. In preparing the list of addresses to be visited, items of non-dwelling property can be readily excluded from the sample by reference to the "description of property" recorded for each item. All composite units which contain a dwelling, e.g. "shop and dwelling," "house and workshop," etc., must, of course, be included in the sample.

Such a sample of rateable units of dwelling property can be safely used without any appreciable error up to some months after it is drawn, for although some 7 per cent. of households move in a year, the rate of building of new dwellings is of the order of only 1½ per cent. of the existing total per year. We in fact normally draw at one time samples large enough to cover our estimated requirements for a period of three months.

The fact that the records are in the form of ledgers with varying numbers of entries to a page makes it impossible to measure sampling intervals as can be done with the National Register. The only safe way of selecting the sample is to take every n^{th} rateable unit throughout the records. This interval of n can be predetermined by dividing the population of the district by 4 times the number of dwellings required in the sample—a calculation which allows a safety factor above the average household size likely to be met with. The counting of this interval is in some cases made easier by the system of numbering of entries employed, i.e. the "assessment numbers." No general instruction can, however, be given on this point since numbering systems differ from district to district, and in any case we have found that there are often discontinuities in the numbering system brought about by amendments to and deletions from the list. In most districts there will be a separate ledger for each parish within which the streets will be listed in alphabetical order, and the properties in each street in numerical or "postman's walk" order. An exception is sometimes made when all council property is listed in a separate ledger.

The normal arrangement of the records thus results in a stratification of the sample of dwelling units by the parish or ward in which they are situated. The effect of this stratification may be illustrated by considering the proportion of dwellings having a rateable value of £30 or over. For example, for a sample of 250 dwellings in Newcastle upon Tyne the error variance of this proportion calculated with an allowance for this stratification by parish was some 30 per cent. less than that which would result from a random selection.

(*b*) *Conversion to a Sample of Households*

We have now selected a sample of rateable units of dwelling property, a proportion of which will contain more than one household. Our data show that in England and Wales 94 per cent. contain one household only, 5 per cent. contain two households and 1 per cent. three or more. It is clearly important that household samples should adequately represent different housing conditions. This would not be achieved if only one household were taken in each dwelling, since households living more than one to a dwelling would then be under-represented in the sample.

It will be remembered that the number of dwellings selected in any district was determined by the number of households required. To obtain a correctly distributed sample of households in this district it would be necessary to interview *all* households living in each dwelling in the sample. But the final sample thus obtained in any one district would exceed the number of households required in the sample for that district to an extent depending on the proportion of dwellings

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with more than one household. Thus unless the final national sample were re-weighted district by district, it would over-represent those areas, e.g. London, which contain a high proportion of multi-household dwellings, and would also slightly over-represent households living more than one to a dwelling. There is of course the possible alternative of rejecting completed questionnaires at random for each district; but this would involve the wastage of about 7 per cent. of the material, and is clearly not to be recommended. These points can be illustrated with data obtained from a sample of 1,500 dwellings in England and Wales:

TABLE 9 (a).—*Dwelling Sample to Household Sample—the Effect of Various Procedures**

Type of household	*Sample distribution obtained*		
	(a) *Taking one household in each dwelling*	*Taking all households in each dwelling*	
		(b) *Without re-weighting by district*	(c) *After re-weighting by district*
	%	%	%
Households living one to a dwelling	93·7	86·9	88·7
Households living two to a dwelling	5·0	9·3	8·5
Households living three or more to a dwelling	1·3	3·8	2·8
All types of household	100·0	100·0	100·0

Column (*c*) in this table gives the correct distribution of households by type. This has been obtained by re-weighting each district—a troublesome process which would have to be applied to all the data of the survey. The unweighted sample (column *b*), while showing little difference from the correct distribution by household type, is nevertheless distorted regionally.

We have found that the following procedure produces a sufficiently accurate distribution of households, and avoids both of the difficulties mentioned above. The investigator calls at the first dwelling on her list and interviews all the households living there up to a maximum of three; in the few cases where there are more than three, three are selected at random. If the dwelling yields two, she deletes the next dwelling on her list and proceeds to the next but one; if it yields three, she deletes the next two dwellings and proceeds to the next but two. This routine is repeated until the list is exhausted, when it will be found that the final sample contains the required number of households. (In the very few cases where the sample in a district will contain one or two extra households, the surplus can be rejected at random with little wastage.)

This procedure, although not in theory bound to do so, in practice produces a very close approximation to the correct distribution by household type. A comparison with the unweighted and weighted distributions shown in Table 9 (*a*) is given in Table 9 (*b*) below.

The distribution obtained by using the deletion procedure [column (*d*)], clearly approximates more closely to the true distribution than the unweighted distribution [column (*b*)], and is very much better than the distribution in column (*a*) in Table 9 (*a*).

But the bias that can arise in any sample estimate through the use of any of the less exact procedures mentioned can easily be exaggerated. For example, estimates of the average size of household made by using procedures (*d*) and (*b*) show negligible departures from the true value, while even the least accurate procedure, (*a*), shows an overestimation of this average by only 1 per cent. Again, the estimates of the proportion of households in the upper Economic Groups obtained from procedures (*d*) and (*b*) do not differ from the correctly estimated value of 7·6 per cent., while procedure (*a*) gives a value of 7·8 per cent. These are both instances where appreciable differences might have been expected because of the differing proportions of households living more than one to a dwelling yielded by the different procedures.

* Based on a sample of 1,500 dwellings.

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TABLE 9 (b).—*Dwelling Sample to Household Sample—the Effect of the Deletion Procedure*

Type of household	*Sample distribution obtained*		
	Taking all households in each dwelling		(d) *Using deletion procedure*
	(b) *Without re-weighting by district*	(c) *After re-weighting by district*	
	%	%	%
Households living one to a dwelling . .	86·9	88·7	88·2
Households living two to a dwelling . .	9·3	8·5	8·8
Households living three or more to a dwelling .	3·8	2·8	3·0
All types of household . . .	100·0	100·0	100·0

(c) *Some Uses of Rateable Value*

Before we leave the rating records it may be of interest to consider some of the uses that can be made of the rateable value data obtained when a sample is drawn. In analyses of household data it has been found better to use for each household an "adjusted rateable value" formed by dividing the rateable value of the dwelling by the number of households it contains. This adjusted rateable value is related to that important characteristic of a household, its economic group (correlation coefficient, $r = 0{\cdot}5$). We have already shown that the arrangement of the rating records by wards leads to an improvement in the distribution of dwellings by rateable value. It can thus also be expected that there will be some improvement in the distribution of households by economic group. This relationship between rateable value and economic group leads one to consider the use of rateable value in the preparation of samples with variable sampling fractions. Thus while for example it is impossible at the sampling stage to apply an increased sampling fraction to households in the highest economic group, it is possible to increase the sampling fraction for dwellings of higher rateable value. One simple way of applying an increased sampling fraction to dwellings of, say, £30 and over rateable value is as follows. The interval at which dwellings are selected from the records is made ¼ of that which would be used for a sample with uniform sampling fraction. Every fourth dwelling selected at this interval is then recorded regardless of rateable value, but the intervening ones are recorded only if they have a rateable value of £30 or over. Such a procedure was used in the Demand for House Fuels survey, though it, in fact, proved of little value.

Furthermore, in the surveys on Consumer Expenditure which we have so far carried out, household expenditure has not shown sufficiently marked variation with rateable value to justify the use of variable sampling fractions in view of the complications which their use involves.

One occasion on which we considered the use of a variable sampling fraction was during preparations for the survey on Expenditure on House Repairs, where it was thought that expenditure might well go hand-in-hand with rateable value. We did, however, decide against this, and preliminary data obtained justified this decision. These are presented in Table 10.

It will be seen that the average expenditure per household approximately doubles from the lowest to the highest rateable value group. The standard deviation shows a similar variation. We can examine what gains would result from the use of a variable sampling fraction by treating the data as from a random sample. It is then possible to compare the error that would arise with a random sample with that which would be obtained with a stratified sample of the same size where the optimum sampling fractions are applied to the rateable value strata. These optimum sampling fractions are of course proportionate to the standard deviations of the strata, so that the sampling fraction used in the highest stratum will be approximately double that used in the lowest. We find that the adoption of such a sampling scheme reduces the standard error of the mean by only 5 per cent. Such a small gain does not justify the considerable additional complications involved.

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TABLE 10.—*The Variation in Household Expenditure on House Repairs with Rateable Value of the Dwelling*

Rateable value of dwelling* (£)	*Average annual expenditure per household on house repairs* (£)	*Standard deviation of the expenditure* (£)
0–9	7·6	14·7
10–19	8·3	15·3
20–29	10·4	22·7
30 and over	14·8	29·8
All values†	9·2	18·9

* Unadjusted value.
† Based on a sample of 1,500 households.

(c) *The Electoral Register*

(i) *Purpose*

An elector cannot vote in a parliamentary or local government election unless his name appears on an Electoral Register. The general qualifications necessary before one can be included in the register are:

(i) British Nationality;
(ii) to have reached the age of 21 years on the qualifying date;
(iii) to have been resident in the area in respect of which the register is prepared at the qualifying date.

These general qualifications entitle a person to be registered as an elector both for parliamentary and local government elections. In addition if a person owns rateable land or premises of not less than £10 rateable value in a local government area other than that in which he resides, he is also entitled to be registered as an elector for local government elections only in the area in which this property is situated.

Persons qualified for a given area either by the general or the property qualification are listed in a single Register of Electors for that area, those with only a property qualification being distinguished by a mark. (The practice of making separate registers for people with property qualifications was abandoned before the publication of the Autumn, 1949, Register of Electors. Service voters are now also included in the general register with a distinguishing mark.)

(ii) *Preparation of Register*

For the purpose of compiling these registers the country is divided up into "registration areas," and the responsibility of preparing the register rests with a Registration Officer in each area.

During the war a system of continuous registration was introduced based on the National Register, returns of persons aged 21 and over being supplied by the local National Registration Officer to the Electoral Registration Officer of the area. This system is still available to Electoral Registration Officers at the time of writing, but each officer is also obliged to make "a house to house or other sufficient inquiry" in his area.

(iii) *Registration Areas*

For parliamentary elections the country is divided into constituencies each of which returns a member to Parliament. These are of two types, borough constituencies and county constituencies, and a list of these constituencies as they exist at the time of writing is given in the First Schedule of the Representation of the People Act, 1948; this list shows their relation to local government administrative districts.

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Each constituency has a Registration Officer. In the case of county or borough constituencies co-terminous with or wholly contained within an administrative county, borough or urban district, the Registration Officer is the Clerk of that county, borough or urban district; in other cases the Registration Officer is one of the Clerks of the administrative districts into which the constituency extends as appointed by the Secretary of State. If there are two or more constituencies with the same Registration Officer they form one "registration area."

Since a single register is used for both parliamentary and local government elections, it must clearly be so divided as to isolate the electors in any given parliamentary constituency, and also those in any ward or parish of any local government administrative district. Where the boundaries of parliamentary constituencies do not coincide with administrative boundaries, as sometimes happens, the register for a given area may be divided into a number of small sections.

These areas will normally be further divided into polling districts. The polling districts are usually specified by letters or numbers running consecutively through a parliamentary constituency, and normally correspond to civil parishes or to subdivisions of civil parishes. The polling district is the smallest unit of area into which the registers are divided.

(iv) *Description of Register*

The register for a given area consists of a series of small booklets, one for each polling district in the area. Each booklet will normally be headed with the name of the "registration area," the name of the parliamentary constituency, the name of the ward or parish (for local government elections), and the name, letter or number of the polling district.

In urban areas the register for each polling district is normally arranged in streets in alphabetical order; within streets the addresses (house numbers, etc.) are arranged in "postman's walk" order, and the electors registered for each address are listed in alphabetical order of surnames and Christian names. In rural areas the electors are usually listed in alphabetical order of surnames throughout the polling district. Electors are allotted serial numbers which run consecutively throughout the list for each polling district.

The only information that can be got from the list about any individual is the surname, Christian name or names and address; no indication of occupation, age or marital status is given. The only information that can be got about any address is the number of electors registered there and their names; no indication is given of their arrangement in households or family units.

As was mentioned above, the register for a given area may include names of persons other than those qualified to be included by the normal residence qualification. Such entries are distinguishable by letters prefixed to the name and are of two main types: (i) entries prefixed by "S-" refer to service voters; (ii) other prefixes ("L-," "LC-," "LR-," etc.) indicate that the person named is registered there in respect of a property qualification only, and that therefore his name will also appear elsewhere in the registers under the address of his residence.

Thus when the registers are used as a record of the adult civilian population aged 21 years and over entries with prefixes should be ignored, since those prefixed by "S-" will refer to servicemen, and those with other prefixes will be duplicated entries which will also appear without prefix elsewhere in the registers.*

(v) *Uses for Sampling*

The Electoral Registers have only one advantage over the other records which we have described, the fact that a complete set is available centrally in London; they have on the other hand more serious disadvantages. We have not in fact drawn samples from them for any major inquiry, though they have been used for a number of pilot surveys. The two main possible uses of the registers are given below:

(*a*) *Samples of the Adult Civilian Population*

Samples can be obtained of the adult civilian population aged 21 years and over, or of either sex separately. The age-range covered is, of course, less than that covered by the National

* The only exceptions to this rule are peers who, since they may not vote at parliamentary elections, will always be registered with the prefix "L–."

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Register, and it is not possible to sample particular age-groups, since age is not recorded. The registers are not revised continuously, but are prepared once a year. A systematic selection of a sample of individuals from these registers is made easy by the fact that each registered elector is allotted an electoral number, but care must be taken to exclude from the counting names prefixed as mentioned above. These numbers run in a continuous series throughout each polling district.

(b) Samples of Households or Housewives

As we have already mentioned, it is not possible to determine from the registers how the electors at a given address are arranged in households. (The practice of distinguishing the householder was abandoned when the franchise for local government elections was extended under the Representation of the People Act, 1945.) Thus households cannot be sampled directly from the registers.

If every n^{th} individual is taken from the registers and information is sought about the household of which the individual forms a part, the resulting sample of households will be such that the probability of any household's inclusion will be proportional to the number of electors in the household, that is, the number of persons aged 21 years and over. Such a sample would require re-weighting as described in the section dealing with the National Register. If this re-weighting were neglected the sample would be biased, as can be seen by comparing columns (*a*) and (*c*) of Table 11, which has been prepared from data collected on a Rating List sample.

The table also illustrates the effect of another device which we know to have been used, that of taking every n^{th} surname. The resulting sample, if not re-weighted, is biased, since households containing, say, a married daughter living with her parents would thus stand an undue chance of being selected.

There are in fact two practical procedures: either every n^{th} individual is selected and the sample is re-weighted, or every n^{th} address is selected. In the latter case the multi-household address has to be dealt with in the same way as the multi-household rateable unit of a Rating List sample.

TABLE 11.—*The Effect of Incorrect Sampling Procedures on Household Size Distribution**

Number of persons in household	*Sample distribution that would be obtained*		
	(a) *Taking every n^{th} individual from Electoral Registers*	(b) *Taking every n^{th} surname from Electoral Registers*	(c) *Using correct procedure*
	%	%	%
One	5·4	6·9	7·7
Two	26·5	28·6	30·2
Three	27·6	26·7	26·6
Four	19·8	18·2	18·0
Five or more	22·7	19·6	17·5
All numbers	100·0	100·0	100·0

* Based on a sample from the Rating Lists.

To sum up the uses of the main records described above, we would advocate the use of the Rating Records for samples of households or housewives and the National Register for samples of civilian adults, of particular age- and sex-groups, of demobilized persons, and also for surveys of the town-planning type.

(6) OTHER SAMPLING METHODS EMPLOYED

Other records have been used on occasion, such as the Food Reference Leaves, the local registers of blood donors, and records of men certified by the Silicosis Board. The Food Refe-

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rence Leaves are the cards detached from old ration books and presented at local Food Offices when the new books are claimed. They are filed at local offices in three sections according to colour—green for children under 6, blue for young people aged 6 to 17, and buff for adults. They are generally filed in alphabetical order of surname, and the age is given on the green and the blue cards. It is sometimes more convenient to draw samples of children or young people from these records rather than from the National Register because of the narrower age-ranges covered.

But on some occasions no suitable list of the population is available. For example, for the first inquiry in the Lancashire Cotton Towns carried out in July, 1948, we required a sample of workers in the cotton industry as well as a general sample of civilian adults of working age in these towns. An adequate general sample of persons of working age would have contained too few cotton workers for the analyses required. To overcome this a sample of persons of working age twice the adequate size was selected from the National Register, and the sample was divided into halves by selecting alternate names. All persons in one half were interviewed, while persons in the other half were interviewed only if they were employed in the cotton industry. This method of rejecting ineligible persons at the interviewing stage can only be used when a fairly high proportion of the population selected from the records is eligible for the sample. Otherwise the number of fruitless calls necessary will increase the cost and lower the investigators' morale.

This method was not possible in the survey on Lighting in Offices undertaken in February, 1948. The sample required was one of office workers, who obviously formed too small a proportion of the population that could be sampled from any register. Furthermore we wished to interview them, and to make measurements and observations, in their actual working conditions. No complete list of offices existed giving the number of workers in each. To overcome these difficulties all office workers interviewed in a series of consecutive Surveys of Sickness were asked to give the address of their place of work. In this way we obtained a sample of offices selected with probability proportionate to the number of office workers employed. Four workers, not necessarily including the worker originally contacted, were selected at random in each office. We were thus able to question, and to examine the lighting conditions of, a sample of office workers.

But there are a number of populations for which we have been unable to devise a rigorous sampling procedure. By what procedures can one sample people on holiday, the self-employed, or disabled persons not on the register of disabled persons? In such cases we generally find that the Department asking for the survey prefers us to adopt some less rigorous procedure rather than to abandon the survey, preferring the information thus obtained to the results of inspired guesswork. Such samples will of necessity be of the "quota" type, based on whatever information may be available.

Apart from this use of "quota" samples imposed on us by necessity, we have, as we have said, used the method in the past for samples which could have been obtained by the methods already described, though our use of the method has steadily declined over recent years. Its only recommendations are the speed with which a sample can be prepared and its low field cost, but sometimes these considerations make it necessary to accept the risk of some bias and the fact that the sampling errors are not calculable. The field cost of such a sample will be about half of that of a random sample of the same size and type. The procedure that we have used on these occasions may be briefly described.

Those characteristics which had from experience been found most to affect survey results, i.e. sex, age, occupation and economic group, were used for setting quotas. A specimen quota sheet is shown in Table 12. The numbers set for each group were based on regional analyses of data collected on the three most recent Surveys of Sickness available. Regional quotas were distributed among a sample of administrative districts (selected as described earlier in this paper) in proportion to the number of interviews required in each, care, of course, being taken to allocate quotas of agricultural workers and miners to those districts in the sample in which they were likely to be found.

The procedure illustrated by this quota-sheet attempts to avoid some of the more obvious biases to which the method is liable. But though this procedure is probably an improvement on the rather casual methods which have sometimes been used by others, it is clear that it still leaves considerable scope for selecting a biased sample.

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TABLE 12.—*Specimen Quota Sheet*

SAMPLING INSTRUCTIONS AND QUOTA

Interviewer..... *District*.....

For this survey we are using the method described on page 44 of the Interviewers' Handbook. This is a sample of adults of all ages, an adult being a person who has left school. Your quota is set out here, and tells you how many men and women are required in different occupation groups. For the largest group, the housewives, the total number has been divided up into those required from each of four economic groups and also into the numbers needed in each of five age groups. You should select houses at intervals until your quota of housewives is complete. Workers should be interviewed at their places of work. Obtain the co-operation of the management and select the people at random, preferably from a list.

*Occupation group**	*Quota*		*Detailed definitions*
	Men	*Women*	
Agriculture . .	—	—	Farm labourers, farmers working on own farm, market and private gardeners, fishermen. (Owners of farms directing employees are *Managerial*.)
Mining . . .	—	—	Mainly coal-miners, but other miners may be included.
Manufacturing .	4	1	All operatives, charge hands and foremen.
Building . .	1	—	Builders, building labourers, road repairers.
Transport, public services	2	—	Workers on railways, trains, buses, tubes, canals, docks, wholesale trade lorry drivers. (Retail van drivers are distributive.) Public services are gas, water and electricity concerns.
Clerical . . .	1	1	Workers (except manual, managers) in offices. One-fifth of these may be attached to factories, shops (including cashiers), or mines.
Distributive . .	2	1	Shop assistants, owners with not more than two assistants, roundsmen, van drivers for shops.
Miscellaneous .	2	1	Workers in hotels, pubs, restaurants, cinemas, entertainments, laundries (managers and clerks excluded); policemen, cleaners of offices and shops, domestic servants, window cleaners, jobbing carpenters, chimneysweeps, postmen, etc.
Professional . .	1	—	Dentists, doctors, nurses, teachers, lawyers, clergymen, high-grade technicians, research workers, etc.
Managerial . .	—	1	Works managers, managers of shops, owners of shops with more than two assistants, supervisory and managerial staff of offices, directors of businesses, administrative grade civil servants, Local Government servants, etc.
All workers . .	13	5	The age distribution of your workers should be roughly as follows:

Age group	16–29	30–39	40–49	50–65	Over 65
Men (13) .	3	3	3	3	1
Women (5) .	2	1	1	1	—

To count as a worker a person must work 30 or more hours per week.

Housewives . .	—	11	Does not go out to work for more than 30 hours per week, mainly responsible for the household house-keeping. The age distribution and economic grouping of your housewives should be as follows:

16–29 years . . .	2
30–39 ,, . . .	3
40–49 ,, . . .	2
50–65 ,, . . .	3
Over 65 ,, . . .	1
Total . . .	11

Up to £4 per week . .	3
£4–£5.10 per week . .	4
£5.10–£10 per week .	3
Over £10 per week . .	1
Total . . .	11

Retired and unoccupied	3	1	All, except housewives, not employed or engaged in a business or profession. One-third are under 60.
Total quota .	16	17	

* This classification is no longer used.

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(7) INCOMPLETE ACHIEVEMENT OF DESIGNED SAMPLE

We have described in the previous sections how the name and address of the individual or the address of the household is selected. When the list is used in the field the investigator will fail to obtain completed questionnaires in some cases. These cases fall into two groups. The first group consists of persons who are ineligible for the sample—e.g. inmates of institutions, who are not included in our sample population—and a small proportion of persons who have died or have left their last recorded address. The second group consists of people who are not found at home after repeated calls, who are incapable of being interviewed or who refuse to be interviewed. The magnitude of this group will clearly depend on the number of calls made at any address. For example, with a sample of adult civilians the chance of an investigator obtaining an interview at her first call is about 1 in 3, though if the person to be interviewed is a housewife not in paid employment the chance is increased to about 1 in 2. It is clear from this illustration that persons with whom interviews are obtained at one call only will form a biased sample, and further calls must be made on persons not contacted on the first call. Experience shows that the bias is reduced to negligible proportions if a minimum of three calls is always made where this is necessary to contact a person. Our investigators are instructed to make inquiries and appointments where possible at the first call, with the result that second and subsequent calls are more fruitful. For example, while 35 per cent. of the sample are interviewed at the first call, 60 per cent. of the remainder are interviewed on the second call, the increased productivity of the second round of calls being clearly the result of appointments. Investigators are encouraged to make more than three calls where a further call would appear likely to produce an interview.

(i) *Analysis of Person Not Interviewed*

In a sample of 8,000 adult civilians the persons we should have interviewed but failed to amounted to 10·9 per cent. of the sample drawn. The reasons for failure to obtain interviews as classified in Table 13 are fairly typical of this type of sample, except for the rather high figure for refusals, which naturally varies with the subject of the inquiry.

TABLE 13.—*Reason for Failure to Obtain an Interview**

Reason	%
Subject out	3·9
Subject away from home	2·0
Subject too ill	0·9
Subject incapable of being interviewed (e.g. deaf)	0·7
Subject did not speak English	0·1
Subject refused interview	2·8
Miscellaneous	0·5
All reasons (proportion of drawn sample)	10·9

* Based on a sample of 8,000 adult civilians.

The 3·9 per cent. of persons who were repeatedly out might have been interviewed if further calls had been made. The 2·0 per cent. away from home could only have been interviewed if calls had been made after the end of the time allotted to the field-work, which would be impracticable for an organization carrying out large numbers of surveys. The next three groups, amounting to 1·7 per cent., clearly could not be interviewed. (In the Survey of Sickness special arrangements are of course made for obtaining information about persons too ill to be interviewed, since illness is the subject of the survey.) The second largest group (2·8 per cent.) consisted of people who refused to be interviewed. The size of this group varies from survey to survey, and we will return to the subject later in this section. The miscellaneous group included cases where weather and transport difficulties (the inquiry was carried out during the winter) prevented interviews being obtained.

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On all inquiries investigators are instructed to return a questionnaire for every person or address issued to them. Where an interview has not been obtained, the reason, as classified above, is given, and any information available about the individual or household is also recorded. This information is of necessity incomplete, but for samples of individuals drawn from the National Register the age and sex of the person is always known, and for rating list samples the rateable value of the dwelling in which the household lives.

Table 14 gives an analysis by sex and age of the persons for whom no interview was obtained in the sample 8,000 adult civilians mentioned above.

TABLE 14.—*Sex and Age Distribution of Persons for whom No Interview was Completed**

Sex and age distribution	*Persons for whom no interview was completed*			*Registrar General's estimate for Dec. 1948 (including Forces)*
	Refusals	*Others*	*Total*	
	%	%	%	%
Males	32	59	52	48
Females	68	41	48	52
Total	100 (222)	100 (649)	100 (871)	100
Males 16–29	13	24	22	28
30–44	30	29	30	30
45–59	24	26	25	24
60+	33	21	23	18
All ages	100 (72)	100 (380)	100 (452)	100
Females 16–29	10	23	18	25
30–44	27	23	25	28
45–59	29	20	23	25
60+	34	34	34	22
All ages	100 (150)	100 (269)	100 (419)	100

* Based on 10·9 per cent. of a total sample of 8,000 civilian adults.

It will be seen that the main difference revealed in this table between the group of persons not interviewed and the general population is that the former contains a higher proportion of males. However, the bias in the sample interviewed is less than 1 per cent. Within the group not interviewed females predominate among the refusals, but males among the others. It is possible to make some attempt to compensate for the overall bias by re-weighting the sample by age and sex, but it is certain that these people differ from persons of the same age and sex in other respects.

It will be seen that for about half the people for whom no interview was completed the reasons given suggest that the person is out of the house more than the average. The possible effects of the loss of such persons from the sample can be examined by considering the variation of the particular variable with the number of calls required to obtain an interview. Some data for two variates which might be expected to show considerable variation of this kind are given in Table 15.

It will be seen that both the average expenditure on meals in catering establishments and the average number of visits to the cinema increased with the number of calls (up to three) required to obtain an interview, though the increase from those interviewed after two calls to those interviewed after three is considerably less than the increase from one to two. Too much attention should not be paid to the figures for persons not interviewed until four or more calls had been

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TABLE 15.—*Analysis of Two Variates by the Number of Calls Required to Obtain an Interview*

	Average expenditure on meals in catering establishments per adult per week* (*shillings*)	*Average number† of visits to the cinema per adult per month*
Persons interviewed after one call	1·83	2·02
Persons interviewed after two calls	3·10	2·44
Persons interviewed after three calls	3·88	2·47
Persons interviewed after four or more calls	3·61	2·00
All persons interviewed	2·69	2·25
Adjusted value	2·75	2·26

* Based on a sample of 3,000 adult civilians, April, 1949.
† Based on a sample of 3,260 adult civilians, October, 1946.

made, since not all persons missed on the third call were revisited. We have calculated an adjusted value of the averages on the assumption that the mean value of the variates for all persons not interviewed because they were not at home was equal to that for persons interviewed at the third call. It will be seen that the resulting changes in the overall averages are small; for most variables they will be even smaller.

(ii) *Refusals*

We have already shown an example of an individual sample in which the proportion of individuals refusing to be interviewed was 2·8 per cent., and in Table 14 we examined the composition of this group. It should be pointed out that on all surveys our investigators have instructions to make clear at the outset to all potential informants that there is no compulsion to answer any questions and that the inquiry is entirely voluntary. Those who wish to refuse are at liberty to do so. It will be seen that women predominate among those refusing, and older people of both sexes. The reasons given by these people for refusing are difficult to analyse, though about half of them, mainly women, said that they had no time or "couldn't be bothered." It should be noted that refusals as classified here include all people on the investigator's list whom she saw in person without obtaining an interview; thus they will not all be people who were in general unwilling to be interviewed, but will include some who simply could not spare the time.

The proportion of people refusing to be interviewed varies with the subject and type of the inquiry. For inquiries where the person is simply to be interviewed and is asked to answer a series of questions the proportion ranges from about 1 per cent. on the Survey of Sickness to 3 per cent. On other inquiries where the person is asked to do more than merely answer questions, the proportion refusing may rise considerably. For example, in a series of inquiries into the nutrition of housewives in three London boroughs and in Luton certain groups of housewives, interviewed at home, were asked to volunteer for medical examination at a local clinic; only 40 per cent. of them agreed to this examination. On a more recent inquiry into the nutrition of schoolboys in families of the lower economic groups, the mother was asked to keep a detailed record of the boy's meals for a period of one week. This involved the weighing and/or measurement of all food. Only 8 per cent. of the mothers refused to keep such a record, although a further 8 per cent. failed to keep a complete record. On such surveys where a high refusal rate is to be expected we find it advisable to begin with a short interview in order to obtain classificatory data and answers to questions relating to the subject of the inquiry. This enables some estimate to be made of any bias arising from subsequent refusal to co-operate. A somewhat similar problem arises in the case of panels.

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(iii) *Panels*

The purpose of recruiting a panel is normally to obtain from a sample of persons detailed information about their expenditure or other behaviour over a period of time in cases where there is some doubt as to whether this information could be recalled from memory at a single interview. The main disadvantage of a panel is that the sample may soon cease to be representative because of defections from its membership. Some experimental work of this nature was done in the series of inquiries into expenditure on clothing. It involved the last three samples [(iv), (v) and (vi)] of the series shown in the Appendix. The first of these samples was interviewed in October about their previous three months' expenditure. At the conclusion of the interview each of these housewives was asked to join a panel. This panel continued in operation until February. The housewives were asked to keep monthly records, which were collected each month. However, by February only some 60 per cent. of the original sample were still contributing. With such losses serious bias might be expected. Some idea of the bias could be obtained by comparing the survivors with the original sample by means of the classificatory data obtained at the original interview. Further evidence was got by interviewing two other separate samples, one in January and one in February, and from both of these samples information was obtained about expenditure during the previous three months.

This example illustrates the precautions we feel to be necessary when dealing with panels, where failure to obtain complete information about the whole of the sample may be considerable. Such failure to obtain information from the whole of the sample is also likely to occur in postal inquiries.

(iv) *Postal Inquiries*

During this period we have made little use of postal questionnaires. Experience (7) elsewhere has shown that the use of a postal questionnaire with housewives or the adult civilian population produces biased samples because of non-response. Greater success has been achieved with special groups of the population who are better educated than the average and have a special interest in the subject of the inquiry. Such a group was involved in the inquiry (8) made by the Working Party on Midwives, for which the Survey acted in an advisory capacity. The main part of the inquiry consisted of sending a questionnaire to all those midwives who had notified the Central Midwives' Board of their intention to practise in 1944. (Midwives, although qualified, have to notify the Board each year of their intention to practise.) To test the design of the questionnaire and to assess the effect of reminder letters a systematic selection of 250 names was made from the English register of midwives. A copy of the draft questionnaire with a covering letter was sent to each midwife, and a reply within a fortnight was asked for. When after three weeks the returns began to decline, a reminder letter was sent to those who had not returned the questionnaire. After a further three weeks a second copy of the questionnaire was sent, together with both the original covering letter and the reminder letter.

By the closing date, information had been obtained from 84 per cent. of this pilot sample. The returns are analysed in Table 16.

TABLE 16.—*Returns Obtained on a Pilot Inquiry Using a Postal Questionnaire*

	Number in sample	%	
Returned before first reminder	107	42·8	
Returned after first and before second reminder	70	28·0	84·0
Returned after second reminder	29	11·6	
Information received of death or emigration	4	1·6	
Returned by Post Office	27	10·7	
No information received	13	5·3	
Total to whom questionnaire was sent	250	100·0	

It can be shown that, as with recalls on a personally interviewed sample, the first reminder, just as the second call, produces a greater proportionate response than the first approach.

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There were unusual difficulties in this inquiry owing to the fact that the addresses given in the 1944 register were of course out-of-date in many cases; 10·7 per cent. of the questionnaires were returned by the Post Office, showing that the person was no longer living at the address. By using every address available in the various records of the Board, and by approaching hospitals the number of midwives in the sample about whom no information was obtained was finally reduced to 13, some 5 per cent. of the sample.

The final results of the census for England and Wales are given in Table 17.

TABLE 17.—*Final Returns for an Inquiry Using a Postal Questionnaire*

	%	
Returned before first reminder	38·0	
Returned after first and before second reminder	31·7	
Returned after second reminder	7·3	80 8
Returned from alternative address	1·4	
Information received of death, illness or emigration	2·4	
Returned by Post Office	9·2	
No information received	10·0	
Total to whom final questionnaire was sent (16,124)	100·0	

Thus for the main inquiry information was obtained about 81 per cent. of the group. By analysing the data obtained according to the stage at which the replies were received, and by using information gathered in the pilot inquiry, it was possible to show that the biases due to non-response were likely to be small.

The above example is one in which the response was very high if allowance be made for persons who could not be reached by post. This high response was probably due to the fact that midwives were likely to be interested in matters affecting their profession, and were not likely to be deterred by the sight of a printed form. Considerable care was, however, taken in the design of the questionnaire, a number of amendments being made after the pilot.

We will now consider an example where a postal questionnaire was sent to a group more nearly resembling the general population.

During the course of a town-planning inquiry conducted by personal interview we collected the names and addresses of previous members of the households visited who had left the area during the last twenty years, where their present whereabouts were known. The resulting sample of addresses was naturally too widely scattered for personal interviews, but about a year after the original survey a short postal questionnaire was sent to the 740 people whose names had been obtained. After two reminders 45 per cent. of the sample had returned a questionnaire, 16 per cent. of questionnaires were returned by the Post Office, and nothing was heard of the remaining 39 per cent. Up to the date of sending out the first reminder 16 per cent. of the sample sent back a questionnaire, a further 21 per cent. replied between the first and second reminders, and 8 per cent. after the second reminder. Again the total response was fairly high for a postal inquiry addressed to the general population if the difficulty with out-of-date addresses is borne in mind; this may be partly due to the natural interest of the exile in his former home.

(v) *Substitution*

We have thus discussed some of the main problems that result from the incomplete achievement of the designed sample in both personal interview and postal inquiries. On certain of our inquiries by personal interview we instruct our investigators to interview a "substitute" individual if any of the persons on their main sample list cannot be contacted after a minimum of three calls. The names and addresses of such "substitutes" are taken from lists selected from the records at the same time and in the same way as the main sample was drawn. Thus when a "substitute" is to be taken the investigator is faced with the necessity of visiting another randomly selected person, who must be pursued with the same persistence as the original person, with a chance of

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only 1 in 3 of obtaining an interview at the first call. This necessity provides an incentive to re-call yet again on the original person if there appears to be any hope of the next call being successful. It may be noted that an appreciable proportion of fourth and even further calls are made.

Questionnaires relating to "substitutes" (the term is perhaps something of a misnomer, since of course there is no perfect substitute for a person in the original sample not interviewed) are always distinguished, so that the data obtained from them can be excluded from the main analyses if desired.

(8) CONCLUDING REMARKS

In the foregoing sections we have given an outline of the work done in the sampling field by The Social Survey during the last four years. We hope that this will prove of value to other organizations in this country, and perhaps to workers in this field in other countries. We realize, however, that the methods that can be used in other countries may be rather different.

Our organization is fortunate in working in a compact country with good communications. Less than 20 per cent. of the population live in areas which are called "rural districts" for administrative purposes, and only a proportion of these in areas of low population density. Great Britain is, for instance, ten times more densely populated than the United States. Moreover, two sets of complete and up-to-date records are available which are suitable for use in sampling—the National Register and the rating records.

The National Register is administratively linked with the food-rationing system, which helps to ensure that it reflects movements and other changes in the population. Each local register contains a card for everyone living in the district, and it is possible to draw from it samples of any age- and sex-group. The rating records list all the dwellings of the district; there is little delay in adding new property to the list, since this is a source of revenue to the local authority. Once the minor difficulty of the multi-household dwelling has been overcome, these records provide a useful method of sampling households. Furthermore the arrangement of both the National Register and the rating records is such that a systematic selection from them leads to useful stratification.

Our sampling work has not, however, been confined to sampling households or age-groups of the general population of the country. We have been called upon to sample such varied populations as new entrants to nursing, office workers, miners with sons aged 13 to 18, Army volunteers, ex-servicemen, blood donors, and men certified as suffering from pneumokoniosis. Nevertheless over half of our samples were national ones covering the whole population either as individuals or members of households.

Since many of our surveys are designed to provide Government Departments with information on particular current and often urgent problems, we often have little time for *ad hoc* experimentation in sampling. The minimum time between the commissioning of an inquiry and the start of the field-work is set by the time required for a small pilot inquiry and the designing and printing of the questionnaires. This period has sometimes been as short as two weeks. The field organization must be notified at the earliest possible moment of the districts in which samples are to be drawn and interviews made, and of the numbers of interviews required in each district. To meet this need we prepare at six-monthly intervals a series of designs for various sample sizes.

These "general purpose" designs are of the two-stage type, the first stage being administrative districts. The districts are normally stratified by region, by rural and non-rural type, by industrialization index and by zone within the region—factors which have been found to be generally useful. The districts are not stratified by population size, but are selected from strata containing approximately equal populations with probability proportionate to population size and equal numbers assigned to each selected district. The design is such as to give a nearly optimum distribution of the sample from the cost point of view, and it is also administratively convenient. Since it entails a constant overall probability of selection it avoids any necessity for the re-weighting of the results. This last advantage is in fact of considerable importance, and variable sampling fractions are always avoided where possible.

Some idea of the efficiency of the sample design described is afforded by a comparison of the estimated standard errors with those which would be obtained with a single-stage random sample of the same size. The comparisons for five variables are shown in Table 18.

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TABLE 18.—*Some Sample Estimates and Their Standard Errors**

	Proportion of persons working part-time	*Proportion of persons in the highest income group*	*Proportion of persons aged 65 or over*	*Proportion of persons engaged in mining*	*Average number of consultations with a doctor last month*
Estimate of mean	0·047	0·034	0·144	0·021	0·443
Standard error of mean	0·0036	0·0030	0·0053	0·0062	0·0228
Coefficient of variation	7%	9%	4%	30%	5%
Ratio of standard error to that for a single-stage random sample of the same size	1·06	1·04	0·95	2·70	1·03

* Based on a sample of 4,000 adult civilians.

It will be seen that in only one case does this ratio exceed 1·1, and this is a variable which one would not normally attempt to estimate from a sample design of this type. Generally it is safe to assume that the sampling error for variables which we are likely to study will be less than 1·25 times that for a single-stage random sample. If it is assumed that the sampling error will be 1·25 times that for a single stage random sample of the same size, then a sample of 2,000 will give a standard error of less than 1½ per cent. for an attribute possessed by 50 per cent. of the population. Such accuracy will normally be sufficient for administrative purposes. In practice the choice of sample size is often influenced by other factors, such as the expenditure possible, the time available, and other administrative considerations.

While we would not suggest that the sampling problem has been entirely solved, our experience of survey work suggests that sampling errors, being readily calculable, are the least serious errors. Human errors, such as errors in classification on the part of the investigator as in the example we have quoted, and memory errors on the part of the informant, are less easily detected and measured. There are also those types of error which are introduced into the data by the very method by which it is collected. For example, we found that in the survey to predict the demand for campaign stars and medals the attitude of the informant, as expressed in his answers to a standardized questionnaire, was associated with the age of the female investigator asking the questions. There is also evidence to show that the mere presence or absence of a third adult at the interview, even though this person does not speak, tends to affect the replies given. The Social Survey is accumulating data on these points, and perhaps in the future there may be an opportunity to present these findings to this Society.

Acknowledgments

In conclusion we would like to express our thanks to the Registrars General and to their local representatives, to other Government Departments and to numerous Local Authorities throughout Great Britain for the assistance they have given in allowing us to make use of their records for sampling purposes. And to complete our acknowledgments we must thank the 300,000 anonymous members of the public to whom our sampling procedures have led us and who have so readily answered our questions.

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APPEN

SOME SURVEYS CARRIED OUT

Certain surveys made during the period are as yet confidential and so cannot be for some 374,000

Survey	*Purpose*	*Month of field work*	*Population sampled*
Survey of Sickness	A monthly survey made for the Registrar General concerning the incidence of illness and injury	Jan. '46 to Jan. '49 Feb. '49 to Mar. '49 Apr. '49 to Dec. '49	Civilian adults aged 16 and over in England and Wales .. ..
Pneumokoniosis	A survey made for the Medical Research Council and the Ministry of Fuel and Power to establish the kind of employment into which miners certified as suffering from pneumokoniosis have gone and the suitability of such employment	Feb. '46	Men certified as suffering from pneumokoniosis
Road Safety	Studies of the impact of the Road Safety Publicity Campaign made for the Ministry of Transport	(i)Jan. '46 (ii) March '46 (iii) May '46	Civilian adults aged 14 and over in Great Britain
Defence Medal	A survey for the Home Office of the extent to which members of the public intended to apply for the medal with a view to deciding upon the administrative measures necessary to cope with the demand	April '46	Civilian adults aged 17 and over in Great Britain
Recruitment to the Civil Service	A survey for the Treasury of attitudes to employment in the executive and clerical grades of the Civil Service	May '46 to June '46	(*a*) Technical and professional workers aged under 30 without university degrees (*b*) Clerical workers under 30 (*c*) Children in school certificate and post school certificate forms of secondary schools (*d*) Parents of such children
Carpets	A survey for the Carpet Working Party of the Board of Trade to estimate the future demand for carpets	June '46	Working-class households

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DIX

DURING YEARS 1946–49

referred to in this table. These surveys and those listed below together accounted interviews in this period.

Size of sample	*Number of administrative districts at final stage of sampling*	*Notes*
3,000 each month	70	Two-stage stratified random sample; sample of administrative districts selected after stratification by Civil Defence Region, urban and rural type and (urban districts only) by population size, two districts being selected at random from final strata. Within sample of administrative districts so chosen, samples of individuals were obtained by selecting cards at intervals from the National Register. A fresh sample was selected each month. (In the later group of surveys an index of degree of industrialization replaced population-size as final factor for stratification of first-stage units and the districts were selected with probability proportionate to size.)
4,000 each month	70	
4,000 each month	110	
900	..	Every 7th name was taken from records compiled by the Ministry of Fuel covering all men certified by the Silicosis Boards. Where the man had died the relatives were interviewed.
2,000 2,000 2,000	60	Within administrative districts quotas were set for men and women in each occupation group (based on the latest Survey of Sickness figures). In the case of housewives quotas were set by age and economic group. Workers were interviewed at their places of work.
2,500	55	As for Road Safety.
400 300 males 300 females	25	For samples (*a*) and (*b*) quotas were set in each administrative district using information obtained from the 1931 Census and the Survey of Sickness. For samples (*c*) and (*d*) 80 schools were selected so that the number of Council, Foundation, Roman Catholic and Non-aided schools corresponded to the numbers of pupils attending each type. Within each group the correct proportions of Boys, Girls and Mixed schools were chosen. Heads of the schools were then asked to supply the numbers of boys and girls in school certificate and also post-school certificate forms. Quotas were then set by sex and form and the interviewers selected children's names at intervals from the class lists. The children were interviewed at school. At the same time separate lists of children's addresses (not those interviewed) were prepared, and fathers and mothers were interviewed alternately at these addresses.
1,000 800	45	
1,000	30	Within administrative districts quotas were set by economic group, by age of dwelling and type of dwelling. The housewife was interviewed.

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Survey	*Purpose*	*Month of field work*	*Population sampled*
Shopping Hours	A survey for the Home Office to provide evidence on the most suitable closing hours for shops	July '46	(*a*) Civilian adults aged 18 and over in Great Britain (*b*) Holiday makers (*c*) Landladies
Demand for Holidays	A Survey for the Board of Trade on holidays in 1946 and 1947, and the extent to which people were able to obtain the type of accommodation they wanted	Sept. '46	Civilian adults aged 15 and over in Great Britain
Recruitment to Mining	A study made for the Ministry of Fuel and Power into the attitudes of parents and boys resident in mining areas towards mining as a job	Sept. '46	In coalfield areas only *Parents of boys aged* 13–18 (*a*) Non-mining families—Mothers (*b*) Non-mining families—Fathers (*c*) Mining families—Mothers (*d*) Mining families—Fathers *Boys aged* 13–18 (*e*) Schoolboys (*f*) Working boys
"Fill the Ships"	An inquiry for the Board of Trade into public attitudes towards export and the export campaign	Oct. '46	Civilian adults aged 16 and over in Great Britain
Willesden	A survey for the Ministry of Town and Country Planning of attitudes in Willesden towards proposals for moving to a new town	Dec. '46	Residents of Willesden aged 18 and over
Deafness	A study for the Medical Research Council on the incidence of deafness and the potential demand for hearing aids	Jan. '47 and April '47 to Dec. '47	Civilian adults aged 16 and over in Great Britain
Space Utilization	A survey for the Ministry of Works on the use of house space in small inter-war dwellings	March '47	(*a*) Inter-war "parlour" houses (*b*) Inter-war "non-parlour" houses (*c*) Inter-war flats (*d*) Special groups
Domestic Fuel[1]	An inquiry for the Ministry of Fuel and Power into the domestic fuel situation and into housewives' attitudes towards fuel economies	April '47	Housewives in Great Britain

NOTE: (1) = Sampling and field work

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Size of sample	*Number of administrative districts at final stage of sampling*	*Notes*
2,000	60	(*a*) As for Road Safety.
200 200	20 seaside resorts	Holidaymakers were selected at random in public places. The addresses of landladies were secured from the Town Clerks.
3,000	60	As for Road Safety.
300 300 1,500 600 600 900	30	The names and addresses of parents were obtained from the blue Food Reference Leaves. Mining and non-mining families were distinguished by means of the 1939 National Registration Schedules. Only one parent was interviewed in each household. Schoolboys were selected from class lists and interviewed at school. Ministry of Labour figures were used to set quotas of working boys in each district according to industry. Mining was excluded.
3,260	60	As for Survey of Sickness.
1,500 households	1	Addresses were selected at equal intervals from the Rating List for Willesden. An attempt was made to interview all adults aged 18 and over in the households chosen.
30,000	300	Persons interviewed on the Survey of Sickness in these months were also interviewed on this subject.
600	16	Only dwellings erected by the Local Authorities were included. The Local Authorities supplied the names of estates and the plans of the dwellings. Houses were taken at intervals on these estates. Housewives were interviewed.
600	16	
200 600	London 6	
1,500	100	(1) Quotas were set by age and economic status.

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Survey	*Purpose*	*Month of field work*	*Population sampled*
Water Heating(1)	(i) A survey for the Ministry of Works to determine the distribution and use of water-heating appliances in domestic dwellings. (This survey provided the data for *The British Household*)	March '47	Households in Great Britain
	(ii) A further inquiry to investigate differences between summer and winter use of appliances	July '48	Households in Great Britain
Blood Transfusion	A survey for the Ministry of Health of blood donors to the Blood Transfusion Service and of the attitudes of non-donors	May '47	(*a*) Blood donors (*b*) Civilian adults aged 16–64 years in England and Wales
Crockery Stocks	An inquiry for the Board of Trade into domestic crockery stocks and the demand for crockery	May '47	Households in Great Britain
Re-enlistment to the R.A.F.(2)	An inquiry for the Air Ministry into the problems of re-enlisting men to the R.A.F.	June '47	(*a*) Ex-airmen who had applied to rejoin, but who had not done so (*b*) Recruits reporting back at a Reception Centre
Women and Industry	An inquiry for the Ministry of Labour into the problem of recruiting women to industry	July '47	Civilian women aged 16–60 in Great Britain
Fuel Targets and Meter Reading	An inquiry for the Ministry of Fuel and Power into housewives' reception of a fuel economy leaflet and their ability to read meters	Aug. '47	Housewives in Great Britain
Demand for Campaign Stars and Medals	An inquiry for a Treasury Committee to provide estimates of the probable demand for war decorations	Oct. '47	Ex-servicemen and women in Great Britain
Out of School Interests of Schoolchildren	An inquiry for the Ministry of Education into the leisure activities of children	Dec. '47	(*a*) Mothers of children aged 5–12 years (*b*) Mothers of children aged 12–15 years (*c*) Children aged 12–15 years
Men and Mining	An inquiry for the Ministry of Labour into the attitude towards coal-mining of men not employed in the industry	Jan. '48	Male civilians in Great Britain aged 16–60, excluding miners

NOTES: (1)= Sampling and field work carried out within specified administrative districts by Research Services, Ltd.
(2) = Field work carried out

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Size of sample	*Number of administrative districts at final stage of sampling*	*Notes*
6,000	95	(1) The sample was distributed among administrative districts as with the Survey of Sickness. Within each district addresses were selected at intervals from the Electoral Registers.
2,000	95	A sample of 2,000 of the households included in the previous inquiry were revisited. In order to obtain in the reduced sample sufficient numbers of the less common appliances, the households of the main inquiry were divided into five appliance groups, and different sampling fractions ranging from 1 to $\frac{1}{8}$ were used.
1,200	35	(*a*) Names and addresses were selected at intervals from the records of the Blood Transfusion Service.
1,500	60	(*b*) As for the Survey of Sickness.
500	40	Addresses were selected at intervals from the Rating Lists; housewives were interviewed.
700	..	(*a*) Names were selected at a constant interval from records of "non-reporters" in the R.A.F. Records Office.
200	..	(*b*) Names were selected at a constant interval from records at a Reception Centre.
3,000	75	As for Survey of Sickness, cards relating to men, and to women over 60 years of age, being rejected as samples were drawn from the National Register.
500	50	Addresses were selected at intervals from Rating Lists. Housewives were interviewed.
2,000	75	As for Survey of Sickness, cards being selected from those portions of the National Register which contained cards of demobilized or discharged persons.
1,300 400 800	33	(*a*) The names and addresses were selected at intervals from the children's Food Registers. Their mothers were interviewed. (*b*) The mothers of half of the children in (*c*) were interviewed at home. (*c*) 60 schools were chosen so as to give the correct representation to different types. At each school children were selected at intervals from the class lists and given a written questionnaire at school.
1,900	80	As for the Survey of Sickness. Miners included in the sample as drawn were not interviewed.

Analyses by household size suggest that this sample over-represented the large households.

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Survey	*Purpose*	*Month of field work*	*Population sampled*
Recruitment to the Territorial Army and Auxiliary Services(1)	Inquiries for the Combined Services Recruiting Committee on some aspects of recruiting	Feb. '48 to March '48	(*a*) Male civilians aged 16–45 in Great Britain (*b*) Female civilians aged 16–45 in Great Britain (*c*) Ex-servicemen in Great Britain (*d*) Army volunteers (*e*) Army National Service men (*f*) R.A.F. volunteers (*g*) Employers of 500 or more workers (*h*) Members of the Territorial Army
Lighting in Offices	An inquiry for the Lighting of Buildings Committee of the Department of Scientific and Industrial Research into the state of natural and artificial lighting in offices	Feb. '48	Office workers in Great Britain
Nutrition of Housewives	A series of inquiries for the Ministry of Health into the nutrition of housewives in three London Boroughs and in Luton	(i) Dec. '47 (ii) Feb. '48 (iii) Apl. '48 (iv) June '48	Housewives in the Boroughs of: Lambeth Southwark Lewisham Luton
Demand for Holidays	A survey for the British Tourist Board on people's holiday arrangements for 1947 and 1948	Mar. '48	(*a*) Civilian adults aged 16 and over in England and Wales (*b*) A sample of the housewives interviewed in the previous inquiry. (Sept., 1946)
Agricultural Labour Recruitment	A survey for the Ministries of Labour and Agriculture into the problems of recruiting men to agriculture	Mar. '48	(*a*) Male civilians aged 16–45 in Rural Districts of England and Wales (*b*) Farmers in England and Wales (*c*) Male civilians aged 16 and over in Scottish counties (*d*) Farmers in Scotland
National Savings(2)	An inquiry for the National Savings Committee into the savings habits of the public	April '48	The civilian population of England and Wales (all ages)
Public Opinion on Colonial Affairs	An inquiry for the Colonial Office into public knowledge of, and interest in, Colonial affairs	May '48	Civilian adults aged 16 and over in Great Britain

NOTES: (1) = Field work for samples (*a*), (*b*)
(2) = Inquiry carried out by Social Surveys, Ltd.;

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Size of sample	*Number of administrative districts at final stage of sampling*	*Notes*
1,500 } 500 }	75	As for Survey of Sickness, cards relating to persons over 45 being rejected when the sample was being drawn from the National Register.
1,000	75	As for Demand for Campaign Stars and Medals.
300 } 300 }	..	Names were selected at intervals from records at 16 Army Reception Centres throughout the United Kingdom.
225	..	Names were selected at intervals from records at a main R.A.F. Reception Centre in England.
125	12	Names of firms with over 500 employees were selected from records in 12 towns of England and Wales. A postal questionnaire was used.
125	12	Names were selected from the records of local Territorial Associations according to a postal instruction. Selected men were given postal questionnaires.
1,400	110	Office workers interviewed in a series of consecutive Surveys of Sickness were asked to give the address of their place of work. Four workers (selected at random by the investigator from a list) were interviewed in in each office.
350 850 1,000 1,200	1 1 1* 1	Addresses were selected at intervals from the Rating Lists. Housewives were interviewed, and after the interview certain groups were asked if they were willing to be medically examined at a local clinic; those willing were examined. * The inquiry was confined to two wards of this Borough.
500	40	(*a*) As for Survey of Sickness.
300	20	(*b*) See Demand for Holidays, September, 1946.
1,000	19	(*a*) Names and addresses were selected at intervals from the National Registers of Rural Districts in ten counties selected in consultation with the Ministry of Agriculture.
500	10 counties	(*b*) Addresses of farmers were selected at intervals from records of the Ministry of Agriculture for selected counties.
600	8	(*c*) Names and addresses were selected at intervals from National Registers of 8 counties.
350	8	(*d*) Addresses of farms were selected at intervals from records of the Department of Agriculture for Scotland.
3,000	70	In a sample of administrative districts designed as for the Survey of Sickness, samples of the total civilian population were obtained by selecting cards at a given interval throughout both the adult and children's portions of the National Register.
2,000	80	As for Survey of Sickness.

and (c) carried out by Social Surveys, Ltd.
the sample was designed and selected by the Social Survey.

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Survey	*Purpose*	*Month of field work*	*Population sampled*
Expenditure on Clothing	A series of inquiries for the Board of Trade into the way in which clothing coupons were spent and the relationship of prices and coupon-values to buying habits	(i) June '48 (ii) July '48 (iii) Aug. '48 (iv) Oct. '48 (v) Jan. '49 (vi) Feb. '49	Households in Great Britain
The Family Guide to the National Insurance Scheme	An inquiry for the Ministry of National Insurance into the effectiveness of the "Family Guide" booklet in explaining the new National Insurance Scheme	July '48	(*a*) Civilian adults in Great Britain aged 16–64 (*b*) Shopkeepers employing not more than two assistants
The Lancashire Cotton Towns Survey	An inquiry for the Ministry of Labour into the attitude towards the cotton industry of persons of working age in the cotton towns of Lancashire	July '48	(*a*) Civilian adults aged 16–64 in the selected districts (*b*) An additional sample of cotton workers
	A further inquiry to investigate changes since the previous survey	Nov. '49	(*a*) As (*a*) above. (*b*) Sample of new entrants to the industry entering Aug. to Oct., 1949
Consumer Expenditure Series:	A series of surveys made under the guidance of the Central Statistical Office into particular aspects of consumers' expenditure to assist the compilation of National Income Statistics		
(i) Laundry, Dry Cleaning and Shoe Repairs	An inquiry into household expenditure on items indicated in title	(i) Sept. '48 (ii) April '49	Households in Great Britain
(ii) Household Textiles, Furnishing Fabrics	Ditto	(i) June '48 (ii) Oct. '48 (iii) Oct. '49	Ditto
(iii) House Repairs and Domestic Service	Ditto	(i) Dec. '48 (ii) June '49 (iii) Dec. '49	Ditto
(iv) Meals in Restaurants	An inquiry into individuals' expenditure on items indicated in title	(i) Apr. '49 (ii) Aug. '49	Civilian adults in Great Britain aged 16 and over
(v) Pharmaceutical Products	Ditto	(i) May '49 (ii) June '49	Ditto
(vi) Holidays	Ditto	Oct. '49	Ditto
(vii) Hairdressing and Cosmetics	Ditto	Nov. '49	Ditto
Road Safety	A further inquiry into the effects of Road Safety Publicity made for the Ministry of Transport	Sept. '48	(*a*) Civilian adults aged 16 and over in Great Britain (*b*) Women pedestrians

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Size of sample	*Number of administrative districts at final stage of sampling*	*Notes*
500	45	As for Consumer Expenditure Series—see below.
500	45	
500	45	
500	45	
500	45	
500	45	
800	45	(*a*) As for Road Safety.
200	45	(*b*) Quotas were set in each district in proportion to the quotas for sample (*a*).
1,600	15	Names and addresses of persons aged 16–64 were selected at intervals from the National Registers of 15 Lancashire cotton towns. This sample was divided into halves by selecting alternate names. For sample (*a*) all persons in one half of the original sample were approached; for sample (*b*) persons in the other half of the original sample were interviewed only if they were employed in cotton industry.
300		
500	15	(*a*) Names and addresses of persons aged 16–64 were drawn from National Registers in same towns as before.
400		(*b*) Names of all new entrants registering at local Employment Exchange Offices in these districts during the three months were obtained from the Ministry of Labour.
1,500	45	
1,500	60	
1,500	45	Stratification and first-stage sampling of administrative districts as for Survey of Sickness. Addresses of rateable units of property then selected at given intervals from Rating Lists of selected districts; information collected from housewives of households living in selected rateable units.
1,500	45	
1,500	60	
1,500	80	
1,500	60	
1,500	60	
3,000	80	
3,000	80	As for Survey of Sickness.
4,480	120	All persons interviewed for Survey of Sickness in these months were also asked about their expenditure. The sample was extended to Scotland.
4,480	120	
3,000	115	As for Survey of Sickness.
3,000	115	As for Survey of Sickness.
2,000	80	As for similar inquiries of Jan., March and May, 1946.
400	..	Eighty women pedestrians were interviewed at each of 5 pedestrian-crossing sites in London chosen by the Road Research Laboratory; 40 each of "careless" and "careful" pedestrians were selected at each site, these terms being defined according to whether pedestrians crossing the road within a given distance of the crossing did or did not use the crossing.

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Survey	*Purpose*	*Month of field work*	*Population sampled*
Children and the Cinema	A study of the cinema-going habits of school-children made for a Departmental Committee of the Home Office, the Scottish Home Department and the Ministry of Education	Oct. '48	(*a*) Schoolchildren aged 10 and over in Great Britain (*b*) Mothers of school-children aged under 10 (*c*) Mothers of school-children aged 10 and 11
Demand for House Fuel	A survey of present space-heating methods and of probable future demand for solid fuels carried out for the Ministry of Fuel and Power	Nov. '48	(*a*) Households in Great Britain (*b*) Households living in premises of £30 and over rateable value
The Recruitment of Hospital Nursing Staff by Advertisement	An inquiry for the Ministry of Health to assess the success of advertisements in recruiting nurses to hospitals and their value in relation to cost	Apr. '49	Nursing staff who had joined hospitals since July 5th, 1948, and were still there at March 31st, 1949
Nutrition of Schoolboys	An inquiry for the Ministry of Health into the nutrition of boys of certain ages, with particular reference to boys in families of the lower economic groups	May '49	Boys aged 6, 8, 10, 12 and 14 years in England and Wales
Education and Employment	An inquiry for the Ministry of Labour and the London School of Economics into the occupational mobility of employed persons	June '49 and Aug. '49	Adult civilians aged 18 and over in Great Britain
Housing Waiting Lists	An inquiry for the Ministry of Health into the housing conditions of people on Local Authority Waiting Lists	July '49	Applicants on the waiting lists of Local Authorities

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Size of sample	*Number of administrative districts at final stage of sampling*	*Notes*
850 1,000 200	45	One hundred and twenty schools were chosen so as to give the correct representation to different types; at each school names and addresses of children were selected at intervals from the class lists. (*a*) Children aged 10 and over were given a written questionnaire at school; (*b*) the mothers of children aged under 10 years were interviewed at home; (*c*) the mothers of a sub-sample of the children aged 10 and 11 who were given the written questionnaire were interviewed at home to provide for an overlapping comparison between the information given by mothers and children.
3,000	80	As for Consumer Expenditure Series—see above.
350	80	Addresses at constant intervals beyond addresses selected for sample (*a*) were extracted from Rating Lists if they had rateable values of £30 or over.
(*a*) 1,450	..	(*a*) (Non-Teaching Hospitals). Every 6th Management Committee Area in England and Wales was selected from a list arranged regionally; every 2nd hospital in selected areas was taken; lists of all new entrants during the period were provided by selected hospitals; samples of these new entrants were interviewed.
(*b*) 200	...	(*b*) The Committees of 12 principal Teaching Hospitals were asked to supply lists of new entrants, as above; 1 in 6 of these were interviewed.
800	13	Cards were drawn at a constant interval from the Blue Food Reference Leaves of 13 urban Administrative Districts. Mothers of these boys were interviewed. If the Senior Wage Earner of the family had a basic wage of less than £5.10 a week, mothers were asked to keep a detailed record of the boy's meals for a period of one week.
10,000	225	As for Survey of Sickness, cards of persons under 18 years of age being rejected when the samples were drawn from the National Register.
5,000	108	Two-stage stratified random sample; sample of Local Authorities first selected after stratification by region, urban and rural type, and size of waiting list, two or more Authorities being selected at random from final strata; sample of applicants who had returned the Ministry's Buff Enquiry Form were then randomly selected from records of these Authorities.

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Discussion on the Paper by Mr. Gray and Mr. Corlett

Mr. Durant: It gives me very great pleasure indeed to propose formally, but nevertheless very cordially, this vote of thanks to Mr. Gray and Mr. Corlett.

The paper is exceedingly informative, comprehensive and useful; I do not think I need personally pay tribute to it; the size of the attendance at this meeting is in itself the only tribute needed and is evidence of the great interest taken in this subject of sampling.

There are one or two points of detail on the paper that I should like to raise.

On p. 168, paragraph 2 says: "We know, for example, that about 7 per cent. of households move in a year." In inquiries that we have made in each of the past three years, using quota methods, we have found 16 to 20 per cent. telling us that they have moved during the calendar year. That discrepancy between our figures is clearly too big to be overlooked.

I think we would all agree there is really no mystery about sampling. Given world enough and time, all of us could construct a perfect sample of any universe and then make the enquiry. As we know from bitter experience, however, those are not the circumstances in which one is asked to lay out a sample and do the work. The sample has to be as efficient as possible, which means it has to be as small as is compatible with the degree of accuracy required; the work has to be done as economically and also as quickly as possible. As a Fellow of the Society, as a professional worker in the field, and last, but perhaps not least, as a tax-payer, I am interested in the efficiency of the samples used by the Social Survey. In discussing their efficiency one has to bear in mind a factor which many people talking about sampling seem to forget, and that is that all samples have to be interpreted in terms of legs attached to an investigator. One must always remember that in field samples of human populations the work has to be carried out by someone travelling around. The efficiency of the sample and the efficiency of the work done by interviewers are not independent but closely related. On occasion I get the impression that some improvement in sampling could be effected along the lines of saving interviewers a lot of time, trouble and leg work, all of which cost money.

To quote an instance, one knows that they have to call back twice, three times, at houses two hours' journey away, and it is very dispiriting to them. Probably that can be avoided in some cases by taking smaller areas as the sampling unit. I will not develop that point because I believe the seconder wants to say more about it.

I would suggest that it would be very helpful to all of us if the Social Survey, while maintaining its present sampling procedure, could collect data for assessing the feasibility of eliminating these far-away calls.

The present method of sampling used by the Social Survey is mainly possible because of the existence of rationing. But when rationing comes to an end (and we can foresee the end of rationing, I think, perhaps in our lifetime!) the efficiency of the maintenance of the Register is clearly going to decline enormously. That will present the Social Survey with the very serious problem of what alternative means of sampling they are going to employ. I know that in many circles the quota method of sampling is much despised. Nevertheless, I would like to place myself in the distinguished company of Professor Kendall who, in his inaugural lecture recently, asked for experimentation on the efficiency of quota controls as opposed to other methods of sampling. I have here details of experiments carried out in the States four or five years ago by the Bureau of the Census and NORC, where, using a quota sample of 2,578 against an area sample of 30,000, the difference on a large number of factual points was no more than 2.9. That seems to indicate that there is a field for investigation, experimentation and comparison where the Social Survey can operate very much to the benefit of all of us working in this field.

Mr. Moser: I have great pleasure in seconding the vote of thanks to Mr. Gray and Mr. Corlett for their most valuable paper. Their lucid and detailed account will, I am sure, be invaluable to Government departments and other organizations contemplating the use of sampling procedures, and will also encourage bodies using sampling techniques to publish more of their methods and results in future.

It seems to me that the quality of the Survey's work has greatly improved during the last few years and that there have been two main advances in its sampling procedures. The first lies in abandoning the method of quota sampling. There is no need here to go into its disadvantages, but it is not appropriate that surveys on the results of which administrative action is to be based should rely on a method of sampling which is so likely to lead to bias. The chief attraction of quota sampling is its cheapness and although this probably explains why it is still used a great deal by commercial organizations I think the Social Survey's change-over to random sampling is greatly to be welcomed.

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The second and more recent improvement is the selection of the first-stage sampling units. Until quite recently the procedure was to stratify the administrative districts into size groups, as mentioned in the paper, and then the actual administrative districts—say towns—to represent any particular size group were chosen purposively, that is to say, with a view to giving the sample representativeness. This was always rather a weak link in the Social Survey's sampling designs, in-so-far as it introduced a non-random element into the sampling design. With the "probability of selection proportionate to size" design this difficulty is avoided. I should like to ask whether the Survey is changing over completely to this greatly preferable method of selection, or, if not, what method of selection of primary units is being adopted in the remaining samples.

I should also like to ask three questions about specific points in the paper. The first concerns the number of sampling stages. The authors explain that, with the existence of lists, it is possible to use a two-stage sampling design. Taking the example from the paper, Sheffield is given its due of 48 interviews and these, I presume, are taken at random over the whole of Sheffield from the national register. I wonder whether this is not rather uneconomical. Would it not be preferable to introduce an intermediate stage of sampling, say by wards, and thus reduce the cost and time factors of interviewing? This would increase the sampling error, but the reduced cost might make it possible to have a larger sample with the same efficiency. No doubt Mr. Gray and Mr. Corlett have considered this question, but I should be much interested in further information.

My second point concerns substitutes. The authors mention that in some kinds of surveys substitutes are taken. I should very much like to know to what kind of surveys this applies, and why. Is it in order to ensure sufficient numbers for analysis in all the sub-groups? The authors state that the fact that a substitute will have to be taken acts as an incentive to interviewers to follow up their non-contacts for further call-backs. Would it not be better to have a standardized system, ensuring that all interviewers do the same number of call-backs? That links up with the refusal rate which, according to the paper, is generally between 1 and 3 per cent. This seems very low, and I wonder whether Mr. Gray would confirm that this percentage is based on the total number in the original sample without the addition of substitutes. It may seem ungrateful to ask for it after such a detailed and informative paper, but I think more information on this question of refusals and substitutes would be welcomed.

My last specific point concerns panels. I think the authors would agree that, theoretically at any rate, panels would be a suitable form of enquiry for the consumer expenditure surveys. The practical problems of panels are very considerable—chiefly the possible loss of representativeness due to panel mortality—but I wonder whether they are insuperable. I should very much like to have more information on the specific experience with panels referred to by the authors, and to ask whether it would be feasible, for experimental purposes, for the Social Survey to keep even quite a small panel going for a year or more in order to compare its results with the *ad hoc* surveys. The main difficulty with panels in the past has been that no basis for comparing their accuracy with *ad hoc* surveys has existed, and this seems a good opportunity for experimentation.

I will conclude with a comment which is in no way a criticism of this paper and arises, in fact, from its last paragraph. A great deal of work has been done in recent years on the sampling of human populations, and I think most of us would agree that this does not constitute the most difficult part of social surveys. However refined the sampling design, however well the investigation has been planned, ultimately the value of a survey depends on the accuracy of the information obtained by the average interviewer. At present, very little is known about the best methods of selecting and training interviewers, or about the possibility of estimating and controlling interviewer bias, or about assessing the validity and reliability of the data obtained at an interview.

It is much to be hoped that statisticians will turn their attention to these questions, and perhaps the Social Survey will, in the future, have more time, money and staff available to enable them to work systematically on some of these unsolved problems of social surveys.

Mr. Frederick Edwards said that it was much appreciated that there should be in this country a Social Survey which had facilities for studying these problems and producing scientific evaluations of the factors involved. Particularly to be welcomed were the concluding remarks in the paper where the hope was expressed that in future there might be opportunities of reading other papers on such matters as the human errors which took place.

The question of quota sampling had been raised several times already, but it might be useful if Mr. Gray could say a little more about the comparative cost factors involved. It was said in the paper that the random methods were approximately twice the cost of quota sampling methods, and on searching through the paper to find some indication of the absolute cost, the only clue revealed was a mention that one investigator working part-time in a fortnight could do 20 to 30 interviews. That seemed to raise a slight ambiguity in that the text was already concerned with

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part-time interviewers and it had not been possible to understand how many whole-day interviewers' work that represented.

All those who made use of quota sampling would like to be in the position of the Social Survey of being able to make use of random sampling. Mr. Gray had mentioned some difficulties arising from the fact that the national register which was being used was only a transient phenomenon. Be that as it might, it was available at present and could be made use of by the Social Survey. Other people who would like to use it would find the difficulty, mentioned by Mr. Gray, that the records were not kept centrally in London and had to be consulted locally, and that they were not available to the general public.

It was to be hoped that the interest which the Royal Statistical Society had taken in the question of human sampling might help to make such records more readily available.

The use of quota sampling might be considered, then, as a legitimate alternative for people outside the scope of the Social Survey, not (as at present) as almost their only choice.

Mr. L. Moss, who spoke as a member of the staff of the Social Survey, said he would make only one or two general points.

He would first emphasize Mr. Gray's concluding remarks about sampling being by no means the only problem in the work of the Social Survey; in fact, at the present time it was felt that sampling was one of the problems more under control than others which had to be contended with. If the National Register were to disappear in the very near future it would be necessary to devise, procure or construct alternative registers or lists. Our past experience as described to-day, however, gave us confidence that this could be done. The Americans, after all, had no national register, but that did not prevent them using random sampling methods.

As to cost, one must keep a certain amount of perspective on the work of the Social Survey and the way in which it differed from that of those organizations which had chosen to use quota sampling methods. Quota sampling happened to be cheap. It would seem that the onus was not upon the Social Survey, using methods which it knew to be reliable, which enabled it to quantify its results and to produce results upon which sampling errors might be calculated and which took the matter out of the hands of investigators and put them into the hands of the Research Officer (which was where they ought to be); the onus was upon those who used other sampling and more haphazard methods to publish their results.

Returning to his first point, the other problems which had to be dealt with in organizing social surveys were collectively more of a worry than were sampling problems at the present time, although unless sampling were under control one was not in a very good position to do anything effective about the other major technical problems.

On the question of investigator bias, a certain amount could be done on a small scale, but the whole question of measuring bias could only be effectively dealt with in an experimental way if the samples used were under control and drawn by means of a dependable method upon which errors could be calculated. In quota sampling it was not too clear how sampling errors were calculated. With Schedule design it seemed that until there was a completely reliable method of sampling, it was not possible to measure progress, and furthermore the work which the Social Survey had to do—economic studies, morbidity measurement, analyses of housing and population and so on—was very difficult indeed without a sampling method which made it possible to quantify results in a dependable way and to supply sampling errors.

There was the further difficulty that the Social Survey had to assure members of the public who were approached that there was no bias in their selection. The best method known was to tell them something of the way in which the selection happened to be made and to assure them that the person interviewing them had nothing to do with the selection. That was therefore an extra public assurance that there was no bias in the results of the Social Survey if random sampling were used.

The Social Survey had been working on the problems of selection, training and testing of investigators and it was hoped to present other papers, perhaps to the Royal Statistical Society and professional bodies. Although many Social Survey Reports were not generally available because they were made for government departments, who alone had the right to decide whether they should be published, the Social Survey could at least provide accurate accounts of the methods they used and expose them to the criticism of other research workers, and this would be done.

Mr. J. A. Reece said that Part 2 of the paper provided an interesting comparison between the work of the Social Survey and similar work undertaken by business concerns.

The object of market research carried out by the North Thames Gas Board was to provide in a simple literary form reports, with recommendations, that the manager of the section presented to management committees and discussed with chief officers. Special topics were occasionally

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set, but the onus was generally on the section to throw light on important current issues and to anticipate potential problems.

Unlike the Social Survey, only one investigation was undertaken, namely into the commercial and manufacturing implications of the market position for gas, coke and competitive fuels. That investigation was continuous, following trends in time, elucidating enquiries, reflecting new aspects of current interest and correcting disclosed errors. There was close contact with other departments, and relationships were maintained with other gas boards and large undertakings.

The section consisted of a manager, who maintained top internal contacts and reported and made recommendations at that level, a statistical officer, whose scope was roughly that outlined in the paper just given, and an office staff of six carrying on the whole of the preparation and analysis under a senior member, much use being made of the Board's punched card system.

Most of the visits were made by representatives borrowed from the Commercial Department, on special occasions up to six at a time, whose normal duty was to attend at consumers' homes to gas and coke needs. Those representatives rarely worked on market research for more than three weeks at a time. A briefing officer attached to the section travelled to and fro across the area of supply, assuring himself on the district that the representatives were fully aware of and were carrying out what was required. All members of the section occasionally undertook visiting.

The only method of sampling found necessary was the selection of every n-th item in an exhaustive list. Those might be consumer cards or, where any non-gas households were also covered, the electoral roll. The whole address had sometimes to be taken for the elector chosen and if several households were found there the results were scaled down to unity. From the electoral roll sample, gas consumers might be picked out and results checked against the gas sample.

The calculation of the standard error was often sobering and considerably conditioned what and how much was said in the literary report. On the other hand, a great deal of useful miscellaneous information was obtained as a by-product of the work and was passed to the proper quarter. In the past three years about 40,000 visits had been made.

There was a small but persistent proportion of "persons out" with whom it was not tactful to force an interview. This was because of the need to keep on the best terms with consumers, constituting as they did the permanent business of the board, although, in general, relations were such that a great deal of information might be obtained inside consumers' houses in the most cordial manner. Even where a visit was missed the consumption of gas and type of neighbourhood were known and often a very good estimate could be made of the appliances in a "usually out" household—for instance, gas-ring and fire and electric light. In any circumstances, the most important conclusions depended on relationship rather than straight censuses and appeared to be covered by Dr. Yates's comments on the subject in his work frequently referred to in the paper.

Dr. YATES congratulated the Social Survey, not only on the paper itself but also on the progress that had been made since the last report to the Society by the Survey on their sampling methods.

He recalled that when in 1946 he had read to the Society his review of sampling methods (*J.R.S.S.*, **109**, 12) he had ventured to criticise quota sampling, and had even been rash enough to quote some extracts from the Social Survey paper which he thought illustrated the difficulties and dangers of quota sampling. For this he had been somewhat taken to task by Professor Glass and others. It was, therefore, interesting to find that the Social Survey had now virtually abandoned quota sampling. He felt sure they were right. For their type of work—he would emphasize "their type of work"—he was fully in agreement with Mr. Moss that the objectivity obtained by random sampling was a real necessity.

In the ordinary way, when examining the results of sample surveys, on which administrative decisions depended, one did not want to be continually looking over one's shoulder for fear that there was some hidden distortion of the results due to some defect in sampling procedure. It was worth paying quite a large price to avoid that.

Dr. Yates would like to ask whether the statement that the cost of random sampling was twice that of the quota method was really objectively based. Probably the statement was based on the cost per interview. If so, this was scarcely a fair comparison. It was necessary to know the cost per unit of information. It could be said with confidence that a single interview was not likely to give more "information" if the selection was by quota methods (in the statistical sense) rather than by a well designed random method; it probably gave considerably less information when bias and other things were taken into account. It might well be that random methods would show a substantial gain over quota methods if the reckoning were on the basis of the cost for a given amount of information rather than the cost for a given number of interviews.

It was gratifying to see that sampling on the basis of "probability proportionate to size" had

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been introduced. He was pleased to see the presentation of the formulae giving the sampling errors of two-stage random sampling with uniform overall sampling fraction and probability proportionate to size at the first stage. He thought that this was the first time that these formulae had been presented. As far as he remembered previous papers had only given methods of calculating the sampling error from data relating to a sample selected with uniform probability at the first stage.

Dr. Yates urged the Social Survey to keep their promise and to continue to publish accounts of the progress they were making in survey technique. They would certainly have many other interesting things to describe. In particular, he hoped they would say something about the results they obtained on the experimental comparisons between interviewers which they had promised to undertake. That was most important work and the Social Survey were in an excellent position to do it; they had a considerable organization and facilities to organize work of that kind. It would also be interesting to hear more about methods of analysis of survey data. This question of analysis and presentation of results was one of the major problems to be tackled in survey work. At present it was customary to present the means or percentages relevant to each classification separately, disregarding the other classifications. It was, of course, well known that complications were introduced by differing proportions of the other classifications, and the theory required to eliminate disturbances of this kind was also known. Practical methods required to be developed, however, and tried out in practice. With the wealth of material which the Survey had collected, he hoped that they would try their hand at this task and relate the results.

Mr. FERRABY asked that quota sampling and random sampling should not be discussed as simple alternatives, one excluding the other. It was not in every case the facts which were the ultimate objective of a survey; very often the ultimate objective was a judgment, the facts being required only as a basis for that judgment. In those cases, the margin of error of the judgment was not susceptible to numerical calculation and it might well be that an error in the facts which could not be exactly measured might be permissible. There was evidence that in most circumstances the bias introduced by quota sampling was fairly small. It was possible that results obtained by that method might have a sufficiently good chance of being correct to form a basis for the judgments which were the ultimate outcome of the survey.

Particularly that might be the case when things were being measured which were very difficult to define—if, for example, a survey were being used to investigate the distribution of opinions. Even in the laboratory, psychologists had not yet succeeded in measuring opinion. To double the cost of a survey in order to produce figures whose error could be numerically estimated might be wasteful if the matter were not primarily susceptible to numerical measurement. It might be that so much judgment had to be used to interpret the results that the small increase in numerical accuracy was not worth the cost. In such cases, the interpretation was perhaps as much an Art as a Science, but it could be done a very great deal better as the result of near-representative sampling than on the basis of sitting in an armchair and guessing the answer.

It was not only in relation to opinion that these remarks applied. Each problem had to be examined to find out just how important it was to know exactly the size of the error involved.

Mr. MASON said the current tendency to concentrate on the theoretical variance in a technique often obscured the vital need for all practical factors to be allowed for. Only in Government work were there facilities at present for using purely random samples. Even these were partly "systematic," and again the calculated margins of error could not be taken necessarily to apply to the results of any one actual sample. Other things, such as bias in questionnaire, or in areas taken (even when selected by chance) had to be allowed for. In commerce, the lack of lists, the expense involved and the time factor were big obstacles. But there was fortunately no need for complete randomization to ensure that Business was given a reliable picture of what was happening. It might well be also that, so far as the statistical variance was concerned, quota—especially representative quasi-random—methods would prove more precise than the random one when a theory was developed; again, with human populations, bias in collection of data might always outweigh any such differences. Thus, what practical researchers looked at most carefully was the consistency of the results, both within themselves and in the light of other knowledge of the position. A general shift up or down was not, therefore, so important.

It would be most helpful if two simple experiments could be carried out: (*a*) taking a suitably stratified random sample and comparing it with a scientifically operated quota one carried out simultaneously in circumstances to which both types were suited (say, on housewives); (*b*) to see if costs could reasonably be cut, taking the usual sample (repeating recalls until complete) but taking a parallel sample going to the housewife next door, when a person was out on the first call. The relationship between these samples would be of considerable interest.

Complete randomizing seemed unnecessary in practice. It was more important to find how

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to measure or assess the main unchecked factors when judging the validity of results. With a carefully organized set of interviewers and well-controlled sample many of these would balance out. The most important biases seemed latent in the relationship of questionnaire to respondent. Why, for instance, was the variance of an attribute apparently independent theoretically of the quality of the interviewing technique? More literature on attributes would help commercial researchers. There seemed many psychological factors to be taken into account.

Mr. MASON subsequently wrote: If the fact that a person is out is relevant then this must surely be primarily due in practice to the fact that he or she is at work. How can such be approached in Social Survey work without evening or week-end work? In the quota methods these classes would be sampled, in proportion, separately. Would not a comparison of the differences between the results of such samples (taken in factory, shop, office and street) and those of the persons found "out" at first call provide further evidence?

Differences between first call replies and the final completed sample need not be entirely due to different qualities in the population of "outs"; one would expect such differences between any "part-samples." What is so remarkable in commercial practice on "incompletely random" methods is that the variation found seems to be smaller than one might expect.

Dr. BRANSBY wished to associate himself with the principle propounded by the two previous speakers in regard to more exact investigations. The point, he said, might be illustrated by a survey he made some time ago in which information on milk consumption was collected from 300 households. A random sample of 100 of those 300 households was then taken and the data analysed in exactly the same way. It was found that having decided on the precision with which the information was required, the larger sample gave no better information than did the smaller one. In fact, the work of collecting the information from 200 out of the 300 households was, for practical purposes, wasted. The same kind of problem was encountered over a wide field. For example, he had recently been concerned with the statistics of part of the National Health Service which required the sampling of about 8 million complicated forms. If the size of sample taken was, say, twice as large as was really necessary, the amount of work involved and the cost of doing it was increased out of all proportion. An important aspect of all survey work was to try and decide the precision with which the information was required. Perhaps Mr. Gray would say whether he discussed that aspect with his clients and whether the sample size was then decided, taking into account both the sampling procedure and the precision of the information. On looking through the list of surveys in the appendix it seemed that the information required in some need not be very precise and that in consequence a relatively small sample would be sufficient.

On the question of quota versus random sampling, Dr. Bransby said that it was not a matter which should be settled empirically. Some kinds of surveys obviously required random sampling, but there were others which had only to provide broad estimates and for which quota sampling might be sufficient. While quota sampling could not give better or more reliable information than random sampling, there might well be cases where, for practical purposes, the information obtained was as good. The relative merits of the two methods of sampling for various kinds of surveys should, and could, be settled by field investigations.

Mr. GRAY, in reply, said he was sure Mr. Corlett would wish to join him in thanking members for their kind reception of the paper.

On Mr. Durant's point, with regard to the 7 per cent. of households who moved in a year, the question had been: "Was this household at this address a year ago?" so the figure referred to households and not individuals as Mr. Durant's did.

He thought Mr. Moser must have misunderstood the earlier sampling procedure. The main change had been to "probability proportionate to size," but even in the old days the first-stage units had been selected at random. Mr. Moser may have been misled by the remarks about attempting to get a geographical spread, when a zoning device had been used which was similar to that illustrated in the example given.

It was true that some reduction in cost might be achieved by using wards as the unit. The difficulty was that a start would be made with perhaps 30 interviews in a town and to achieve any real reduction in the cost it would be necessary to concentrate them very much, and the wards differed considerably in rateable value, as would be seen from the examples given. The error might be increased for the proportion of people in different economic groups, which was one of the most important things in all survey work. Differences would be encountered between one variable and another, and it was not really possible to generalize.

As to substitutes, they were not used where a high refusal rate was expected. In any case the substitutes could always be analysed separately. It has been standard practice for years to code every schedule as either original or substitute. In any case, there was always the number of calls, and an illustration was given in the paper of the use made of that.

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Substitution was rather useful in that it did fill in the gaps and gave equal numbers in the various towns, which was quite useful in the analysis stage. It also had its uses as a target for the interviewers. They had an attainable target then.

The rate of refusals was based on the original list, as was the analysis of people not interviewed. One of the reasons for the low figure at refusals was possibly the fact that interviewers went to the door knowing the full name of the person, and the age, which meant that they could knock on the door and ask for the person by name. The purpose of the survey was always explained very thoroughly and the subjects were assured that they need not answer the questions—this usually produced immediate co-operation!

He wished to thank Dr. Yates for his remarks; he had himself always been in favour of random sampling.

He did not understand Mr. Ferraby's point that in opinion surveys a random sample was less necessary. It seemed to be just on those questions of opinion that the selection of the sample was so important. The quota sample missed certain types of individual. In a recent experiment when every fifth person passing in the street had been stopped, a refusal rate of 20 per cent. had been experienced. That was accounted for by people rushing along, but those people who rushed along may have had a certain set of opinions. There were, therefore, great dangers in assuming that merely because opinions were being dealt with the quota sample could be used more effectively than with factual matters. At least factual statements could sometimes be checked afterwards.

As to Mr. Mason's question about selecting the housewife next door, if she was found at home she was a stay-at-home just as much as the other people found on the first call. The fact that she was in was one of her characteristics, just as there were a certain number of people who were not in. Therefore going next door would upset the sample considerably. That was shown by comparing the results for people found in on the first call, second call, third call and so on.

Dr. Bransby had asked whether enquiry was made about the precision needed. He personally always did so; the trouble was that the department concerned often could not say.

That seemed to deal with most of the queries raised. He had not dealt much with quota sampling. It had to be realized that not only did cost enter into it but, as had been pointed out, time as well. It was possible to have a quota sample prepared and to go into the field with a questionnaire at very little notice but it did take rather longer to prepare a random sample. That question of time entered into all survey work. A survey was never asked for in time; the results were always wanted in about a fortnight, or something like that. If departments requested their surveys earlier it would be possible to put a little more time into experimental work. Frequently, however, the data necessary to improve the sample would require an enquiry as large almost as the sample which was going to be used. If, for example, an effort were to be made to distribute it in the best possible fashion between towns, it would be necessary to carry out quite a number of interviews in a number of towns to determine between-town variations. More could be done of course, if the survey were a continuing one.

The authors subsequently wrote as follows:

With regard to Mr. Mason's written query we would point out that the Social Survey interviewers do of course interview in the evenings and at weekends. In this way we ensure that our sample correctly represents workers in factories, shops and offices. With a quota sample there is no guarantee that a representative sample of those groups is interviewed simply by conducting interviews in factories, shops and offices.

We should like to thank Mr. P. M. Grundy for pointing out an error in the weights assigned to the components of the second term of equation 7 as given in the original galley.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

William Henry Burrell.
Kenneth Owen Clark.
Kenneth Gault Crawford.
Percival Davies.
James Durbin.
John Edge.
Paul Eisenklam.
Andrew Garvie.
Richard Gye.
Isidore Jacob Good.
Kenneth Victor Henderson.
William Harold Leak.
Alaster Ian McKelvie.
Arthur Leonard Marriott.
Philip Henry Nelson.
Peter Richard Perfect.
George Gabriel Petersen.
Lawrence Arthur Pittam.
James Quartey.
Dudley George Seers.
William Arthur Leslie Smith.
John Alfred Stephenson.
Harold Edgoose West.
John Ridgwell Williams.
Norman Wookey.

Corporate Representative

Arthur John Burkart, *representing* the Hulton Press, Ltd.

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Output Per Head in Different Parts of the United Kingdom

By C. E. V. Leser

Introduction

In a previous paper by H. W. Singer and the present writer, "Industrial productivity in England and Scotland,"* an attempt was made to analyse and interpret the differences in output per head between the two countries at the 1935 Census of Production. The provisional conclusions reached were: productivity in England (and Wales) appears to be about 5–10 per cent. higher than in Scotland; this may be connected with the fact that the proportion of male non-operatives is higher and the average size of establishment larger in England and Wales than in Scotland. Several alternative explanations were brought forward in the discussion when this paper was read at a meeting of the Royal Statistical Society. Following up some of the points made in the discussion, the 1935 Census material was subjected to further analysis and re-examination of the whole problem. In the light of the results obtained, some modification of the provisional conclusions seems indeed necessary.

In the previous paper, a direct comparison between England and Wales on one hand and Scotland on the other was made. This method would not readily lend itself to a comparison between a large number of regions. For this reason, a somewhat different approach has been adopted, based on comparing each country, and later each region, with the United Kingdom as a whole; a comparison between two countries or regions can thus be made indirectly. Therefore, and for some other reasons, this analysis will start again, not from where the previous one left off, but from the beginning.

I am greatly indebted for assistance with this study to Mrs. Anne H. Silvey, who was also responsible for the analysis in Section II of the paper.

I. *General Results for Countries*

From the 1935 Census of Production, averages of (net) output per head can be derived for each of the three countries (counting England and Wales as one) within the United Kingdom, as follows:

Table 1

Country	Average output per head			
	All census trades		Factory trades	
	Value (£)	Index (U.K.=100)	Value (£)	Index (U.K.=100)
England and Wales	225·1	101·2	232·6	101·5
Scotland	213·2	95·8	217·5	94·9
N. Ireland	143·1	64·3	141·0	61·5
United Kingdom	222·5	100·0	229·1	100·0

The table shows a striking difference between Great Britain and Northern Ireland. For all Census trades, output per head in N. Ireland falls short of that in England and Wales by 37 per cent. of the national average. Scotland also, compared with England and Wales, shows a deficiency of 5½ per cent. Taking the factory trades alone, the discrepancies are even more marked; output per head in N. Ireland lies 40 per cent., in Scotland 6½ per cent. below the corresponding figure for England and Wales.

* *J. R. Statist. Soc.*, CXI, 1948, 309.

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Broadly speaking, there are two kinds of possible explanations for this fact. It is well known that output per head varies greatly between one industry and another. Now the industrial structure of the three countries may differ considerably. If England and Wales specialized on industries which have, for the U.K. as a whole, a high output per head, whilst Scotland, and even more so, N. Ireland, specialized on industries with low output per head, then the difference between the averages would be explained. On the other hand, specific factors may operate which tend to lower output, in value terms, in Scotland and N. Ireland as compared with England and Wales, in each industry, or at any rate in the main industries. If the second alternative is true, then differences in productivity suggest themselves, although there are other possible specific factors like differences in hours of work, price levels, etc. It is, of course, possible that both differences in employment distribution and specific factors are partly responsible for the observed differentials in average output per head.

The hypothesis that differences in industrial structure account for the differences in average output per head, may be tested by a very simple method. For each country, we can count the trades in which output per head is above or below the U.K. average for the trade.

The 1935 Census of Production lists 123 trades. However, from now on in the present analysis, we shall omit the 14 non-factory trades. There are sound reasons for doing so. In some of these trades, like mining, output largely depends on natural conditions: others, like public utilities, produce local services which may vary considerably in price. It is suggested that by restricting our work to the 109 factory trades, we shall obtain more meaningful results.

Particulars regarding output per head are not available for all these 109 trades in each country. Eight trades are represented in England and Wales only, a further 38 in England and Wales and in Scotland; for others, figures for individual countries are not disclosed, but a sufficiently clear picture can be obtained, as follows:

TABLE 2

Number of trades in each country

Country	*With output per head*		*Total for which particulars are*		*Total represented*
	Above U.K.	*Below U.K.*	*Disclosed*	*Not disclosed*	
England and Wales	45	15	68*	41	109
Scotland	25	60	85	16	101
N. Ireland	4	32	36	27	63

* Including 8 trades not represented elsewhere, for which, therefore, output per head in England and Wales and in the United Kingdom are identical.

Among the trades for which a straight comparison is possible, those giving an unfavourable result are in a majority of 8 to 1 in the case of N. Ireland and of more than 2 to 1 in the case of Scotland. At least 32—but probably far more—of the 63 trades represented in N. Ireland have a relatively low output there; the same applies for at least 60 out of 101 trades represented in Scotland.

In England and Wales, on the other hand, the favourable cases outnumber the unfavourable ones by 3 to 1. Furthermore, for the 41 "undisclosed" trades, it can be shown that 17 have an output per head above the U.K. average, 8 an output per head below the U.K. average in England and Wales and N. Ireland combined; in the case of a further 3 trades, output per head in Great Britain is above average; for the remaining 13 trades, no comparison is possible. Thus, it appears to be the case that in England and Wales, the majority of industries have an output per head higher than that of the United Kingdom as a whole.

From these figures it may be concluded that differences in employment structure are not, or at any rate not entirely, responsible for the differences in output per head between the three countries. There must be some factors making for different levels of output per head in the same industry and operating, on balance, in favour of England and Wales, against Scotland and even more so against N. Ireland.

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This analysis, however, only provides a qualitative but not a quantitative answer to our problem. It does not tell us whether the output indices of 101·5, 94·9, and 61·5 for the three countries, given above in Table 1, are appropriate, or whether they exaggerate or underestimate the true differences. In order to gain information on this point, more refined methods—similar to those used in the previous study—have to be applied. The underlying principle of the methods adopted here will be to construct an index of output per head in each country, as compared with the United Kingdom as a whole, which is not distorted by the differences in industrial structure between the country and the U.K. This can be done in different ways; but the following two methods seem to be equally plausible, and preferable to any others.

Firstly, assume that in each trade, total U.K. employment was distributed over the individual countries in the same proportion as net output. Take, for any one country, these hypothetical employment figures in all those trades for which particulars are available, and compare the total with the actual employment total in those trades. The hypothetical total will show the employment to which actual employment, at U.K. output per head, is equivalent; its ratio to the actual total will give a "standard index."

Secondly, assume that output in each trade is distributed in proportion to actual employment. Summing again over all possible trades, the hypothetical output totals thus obtained will give "normal output" and "normal output per head," with which "actual output" and "actual output per head" can be compared. The ratio of actual to normal output will give another standard index.

Putting things in a different way, the standard index A, obtained by the first procedure, is the arithmetic average of the ratios $\frac{\text{output per head in country}}{\text{output per head in U.K.}}$ for each trade, weighted by actual employment in the country. Standard index B, resulting from the second process, is the arithmetic average of the same ratios, weighted by normal output in the country (actual employment × U.K. output per head). Index B thus gives a relatively larger weight to industries with high output per head in the U.K. than index A.

Two points, common to both methods, should be noted. Firstly, the trades on which the indices are based are not the same for all the countries. By comparing each country with the U.K., instead of with another country, this difficulty has been overcome without necessitating the complete elimination of trades in which particulars are given for one or two countries only; this will be important in the analysis for regions carried out later.

Secondly, no attempt has been made to apply to a given country employment weights of another country, or those of the U.K., or equal weights for each industry. Such a procedure might lead to applying a large weight to an abnormally high or low output per head figure based on a very small employment figure in a country, and would thus tend to distort the average. For this reason, it is felt that a comparison based on the actual employment weights in each country is preferable.

As seen from Table 2, there are 68 trades in England and Wales, 85 trades in Scotland and 36 in N. Ireland, for which a straight comparison with the U.K. is possible. The employment covered by these "selected trades" is shown in the following table.

TABLE 3

Country	*Persons employed*		
	All factory trades	*Selected trades*	
	Number (000)	*Number* (000)	*Proportion of all factory trades* (%)
England and Wales	4,571·3	3,275·4	71·7
Scotland	466·7	455·1	97·5
N. Ireland	119·6	105·5	88·2

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. The coverage in the case of Scotland and N. Ireland, amounting to 97½ per cent. and 88 per cent. respectively, is sufficiently high to give a representative picture. The coverage obtained for England and Wales is somewhat lower, but this does not matter, since the conclusions for England and Wales can be, more or less, drawn by difference: if output per head is relatively low in Scotland and N. Ireland, it must be relatively high here. The results of applying the methods described above to the selected trades are as follows:

TABLE 4

Average output per head for selected trades

Country	*Standard index A*	*Normal value* (£)	*Actual value* (£)	*Standard index B*
England and Wales . .	101·3	225·9	228·4	101·1
Scotland	94·8	227·2	212·9	93·7
N. Ireland . . .	85·7	155·9	128·6	82·5

According to this table, output per head in N. Ireland appears to be 15½–18½ per cent., in Scotland 6½–7½ per cent. below England and Wales, depending on which of the two indices is adopted. The crude figures in Table 1 gave discrepancies of 40 per cent. and 6½ per cent. respectively. Thus, specialization on different industries in each country does not explain the difference in output per head between England and Scotland; it does explain a large part of the difference between England and N. Ireland, but there still remains a large unexplained differential.

The differences in output per head appear larger if the second weighting method is adopted. This means that the differences are more marked in trades with generally high than in those with generally low output per head.

It may be of interest to consider separately the industries with a relatively high and those with a relatively low output per head in each country. Separate particulars for these groups of industries are given in the following table:

TABLE 5

Country	*Number of trades*	*Persons employed*		*Average output per head Standard index*	
		Total (000)	*Average per trade*	*A*	*B*
England and Wales:					
Output per head—above U.K. .	45 .	2,613·9	58,088 .	101·9	101·8
below U.K. .	15 .	594·9	39,662 .	98·8	98·2
Scotland:					
Output per head—above U.K. .	25 .	100·5	4,018 .	117·3	115·4
below U.K. .	60 .	354·6	5,910 .	88·5	87·2
N. Ireland:					
Output per head—above U.K. .	4 .	2·0	507 .	110·2	110·9
below U.K. .	32 .	103·5	3,234 .	85·2	81·6

Thus, for Scotland and for N. Ireland not only are the trades with a relatively high output per head in a minority, but they are also trades employing relatively few people. On the other hand it is seen that for Scotland, the "degree of superiority" over the U.K. in the "superior" industries (about 15½–17½ per cent.) is larger than the "degree of inferiority" in the "inferior" industries (about 11½–13 per cent.). But the "inferior" industries, being so much more numerous and also having larger employment weights, outweigh the "superior" industries.

So far, our results have been restricted to a selected number of factory trades, which, however, contain the largest part of all factory employment covered by the Census. We shall now endeavour to generalize the results by making allowance for the "undisclosed trades" in each country. If

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we assume that the ratio of actual to normal output (and of equivalent to actual employment) is the same in each country, we obtain the following result.

TABLE 6

Average output per head in all factory trades

Country	*Actual*		*Normal*		*Standard index*	
	Value (£)	*Index* (*U.K.*=100)	*Value* (£)	*Index* (*U.K.*=100)	*A*	*B*
England and Wales	232·6	101·5	230·6	100·6	100·8	100·9
Scotland	217·5	94·9	231·4	101·0	95·0	94·0
N. Ireland	141·0	61·5	164·9	72·0	87·4	85·5
United Kingdom	229·1	100·0	229·1	100·0	100·0	100·0

According to this estimate, Scotland's average output per head lies about 6–7 per cent. below the English figure; for N. Ireland, the difference amounts to 13½–15½ per cent. Whilst N. Ireland strongly specializes in industries with a low output per head, which explains part of the actual output differential, this is not the case with Scotland.

These, then, are the facts. They suggest, although they do not prove, the existence of productivity differentials between the countries. There are, however, alternative explanations. Some of them will be examined in the following sections.

II. *Specialization within Census Trades*

By the methods followed here, the effect on average output per head of specialization on different trades in different countries has been eliminated. It may, however, be queried whether this process has gone far enough. Some of the Census trades are quite heterogeneous, and the individual countries may specialize on quite different products within these trades. For this reason, direct physical comparisons of output per head in each country cannot easily be made.

This difficulty could be overcome if it were possible to divide the Census trades into finer subdivisions. For many trades, the Census gives separate particulars of output per head for a number of subdivisions over the U.K. as a whole. In a few cases, particulars are also given for each region; in others, estimates for each country can be made on the basis of the analysis of output in the country tables.

Out of our "selected factory trades," we have chosen 16 for which an analysis of subdivisions is comparatively easy to make. Twelve of them are included in the selected trades in each of the three countries; they are: tailoring, etc.; boots and shoes; iron and steel foundries; mechanical engineering; motor and cycle; grain milling; cocoa and sugar confectionery; wholesale bottling; soap, candle, and perfumery; furniture and upholstery; brick and fireclay; china and earthenware. Another four (hardware, etc.; electrical engineering; chemicals, etc.; brushes) are included in the selected trades for Scotland only.

For each of these "subdivided trades," we have carried out an analysis similar to that carried out for the total of all factory trades. That is to say, in the same way as we have endeavoured to eliminate the effect of specialization between trades on average output per head over the field of manufacturing, we shall aim to eliminate the effect of specialization between subdivisions on average output per head over the whole trade.

In analogy to the above procedure, we are comparing output per head in each country with output per head in the U.K. for each subdivision. Thus we obtain, for the trade as a whole, adjusted "equivalent employment" and "normal output" figures on which to base our two standard indices (the crude index would be the ratio of $\frac{\text{output per head in country}}{\text{output per head in U.K.}}$ over the trade as a whole).

If we classify the trades according to whether output per head is above or below U.K. level in each country, we obtain the following picture.

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TABLE 7

Country	Trades with output per head		All subdivided trades
	Above U.K.	Below U.K.	
England and Wales . . .	10	2	12
Scotland	2	14	16
N. Ireland	1	11	12

This table was based on the crude figures but remains unaffected if the adjustment is made. Thus, specialization on different subdivisions does not explain in any case the whole difference between output per head in the country and the U.K. In several cases, however, the difference is appreciably narrowed down if our adjusted figures are adopted.

The employment covered by the subdivided trades is as follows:

TABLE 8

Country	Persons employed in subdivided trades		
	Number (000)	Percentage of all factory trades	Percentage of all selected trades
England and Wales . .	1,557·5	34·1	47·6
Scotland	157·4	33·7	34·6
N. Ireland . . .	29·8	24·9	28·2

The following table shows the effect of the adjustments on our two standard indices A and B. The unadjusted figures are obtained by eliminating the effect of the different representations of each trade in the individual countries only. The adjusted figures also eliminate the effect of the different representation of the subdivisions in each trade.

TABLE 9

Country	Average output per head in subdivided trades			
	Standard index A		Standard index B	
	Unadjusted	Adjusted	Unadjusted	Adjusted
England and Wales . .	101·5	101·1	101·2	100·8
Scotland . . .	89·8	92·7	92·6	95·3
N. Ireland . . .	70·9	75·6	71·9	75·6

For the trades considered here, the adjustment made tends to reduce the gap between England and Scotland from about $8\frac{1}{2}$–$11\frac{1}{2}$ per cent. to $5\frac{1}{2}$–$8\frac{1}{2}$ per cent. The gap between England and N. Ireland is also reduced from about 30 per cent. to about 25 per cent. If we can assume that similar conditions apply to the remaining trades, then specialization on different products within a trade would seem to account for part, but not the whole of, the difference in levels of output per head between England and Wales, Scotland and N. Ireland.

III. *Regional Differences within Countries*

The first section of this analysis tended to show that the differences in average output per head between England (and Wales) and Scotland are not due, and those between England and N. Ireland only partly due, to differences in industrial structure, but that some specific factors operate tending to produce a relatively high output per head in England. In the light of the

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results of the second section, this conclusion may have to be somewhat qualified, since specialization on different subdivisions of a trade seems to be partly responsible for the differences in output per head. Nevertheless, it seems to remain true that comparing each trade—or even each subdivision of a trade—in England and Wales with its counterpart in Scotland or N. Ireland, England shows the higher output per head figure in the majority of industries and on the average taken over all manufacturing.

It is possible that a systematic factor operates, not in each country as a whole, but in one or a few regions of a country, and thus tends to raise or depress the average for the country. In particular, it may be suggested that average output per head is abnormally high in the London area, and that there is no difference between Scotland and the remainder of England and Wales, whilst N. Ireland alone has an abnormally low output per head. If this hypothesis is correct, it will necessitate a substantial modification of our conclusions for Scotland.

We shall test this hypothesis in its general form, by investigating whether there are any substantial differences in output per head between individual regions. This can be done by using the same method as that applied to countries.

The Census distinguishes 18 regions, of which 13 are in England and Wales, 4 in Scotland, and 1 is formed by N. Ireland. Closer inspection shows that in region 11 (Cumberland and Westmorland) and region 13 (North Wales) there are so few trades for which particulars are given, and such a small number of employees in these trades, that individual results for these regions would have little value. For this reason, region 13 has been combined with region 12 (South Wales) and region 11 with region 4 (Northumberland, Durham and North Riding). In the Census tables, region 11 has frequently been combined with region 10 (Eastern England); but this combination would have little meaning and has therefore been rejected. For the resulting 16 regions, the Census gives the following figures:

TABLE 10

Region	*Average output per head*			
	All trades		*Factory trades*	
	Value (£)	*Index* (*U.K.*=100)	*Value* (£)	*Index* (*U.K.*=100)
England and Wales:				
London area (1)	271·7	122·1	276·4	120·6
North West (2)	202·3	90·9	199·9	87·2
West Riding (3)	200·1	89·9	201·3	87·9
North (4, 11)	191·6	86·1	222·1	96·9
Birmingham area (5)	220·9	99·3	223·6	97·6
East Midlands (6)	206·9	93·0	213·6	93·2
West Midlands (7)	270·0	121·4	298·4	130·3
South (8)	238·2	107·1	261·8	114·3
South West (9)	221·8	99·7	243·8	106·4
East (10)	239·2	107·5	253·8	110·8
Wales (12, 13)	203·8	91·6	258·8	113·0
Scotland:				
West (14)	213·7	96·1	216·1	94·3
East (15)	220·3	99·0	230·1	100·4
South (16)	197·6	88·9	191·9	83·8
North (17)	199·3	89·6	205·1	89·5
N. Ireland (18)	143·1	64·3	141·0	61·5
United Kingdom	222·5	100·0	229·1	100·0

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The names adopted here for the individual regions are not in every case exactly the same as those given in the Census, but have been devised to be as short and descriptive as possible.

The table shows considerable variations in output per head between regions within England and Wales and within Scotland. The difference between the highest and lowest value for factory trades in England amounts to almost £100 or 43 per cent. of the U.K. average; in Scotland to £38 or 16½ per cent. (for all trades, in England to £80 or 36 per cent., in Scotland to £23 or 10 per cent.). The Scottish regions are at the lower end of the scale but not definitely below England and Wales; three of them have a higher output per head than either Lancashire or the West Riding. N. Ireland continues to be far below any other region.

Of course, these figures are influenced by the employment distribution of the region and therefore prove nothing. Slightly more information can be obtained from a count of trades with output per head above and below the U.K. average, as far as possible. The results are shown in Table 11. The published figures do not tell us exactly how many trades are represented in each region, without their particulars being disclosed, and how many are not represented at all.

TABLE 11

Region	*Number of trades with output per head*		
	Above U.K. average	*Below U.K. average*	*Total disclosed*
England and Wales:			
London area	67	23	91*
North West	32	57	89
West Riding	24	50	74
North	8	42	50
Birmingham area	29	47	76
East Midlands	27	33	60
West Midlands	11	29	40
South	21	31	52
South West	9	35	44
East	14	35	49
Wales	12	28	40
Scotland:			
West	21	50	71
East	15	33	48
South	3	17	20
North	4	20	24
N. Ireland	4	32	36

* Including one trade not represented elsewhere.

The table shows a marked contrast between the London area and the remaining regions. Whilst in the London area, almost 3 out of 4 trades show an output per head higher than average, the majority of trades in each of the other regions have a lower than average figure. On first sight, it would thus appear as if a specific factor, raising output per head, operated in the London area alone. To conclude this from the evidence of Table 11 would, however, be a fallacy. Owing to the larger weight which the region has in the national average, the high output per head in this region tends to raise the U.K. average to such an extent as to conceal the differences which may exist between the remaining regions. In order to obtain conclusive results, it is necessary to apply the more elaborate methods described in the first section.

The trades shown in Table 11 will form the selected trades for the purpose of our analysis. Table 12 shows how far they are representative for each region.

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TABLE 12

Region	*Persons employed*		
	All factory trades Number (000)	*Selected trades* Number (000)	*Selected trades* Percentage of all factory trades
England and Wales:			
London area	1,083·5	1,073·9	99·1
North West	1,005·0	996·1	99·1
West Riding	573·3	566·7	98·8
North	167·8	152·6	91·0
Birmingham area	734·3	720·0	98·1
East Midlands	377·4	357·6	94·8
West Midlands	102·5	63·1	61·5
South	173·3	162·1	93·5
South West	84·1	78·0	92·8
East	164·8	138·2	83·9
Wales	105·3	87·7	83·3
Scotland:			
West	256·0	241·1	94·2
East	136·1	112·3	82·5
South	33·6	28·6	85·0
North	41·0	31·5	76·9
N. Ireland	119·6	105·5	88·2

It is seen that with the exception of one region, the selected trades account for more than 75 per cent. of all factory employment covered by the Census. For the main industrial regions, viz. the London area, North West England, the West Riding, the Birmingham area, the East Midlands and the West of Scotland, the coverage amounts to more than 90 per cent. For these regions, and with some qualifications for the remaining ones, we can therefore expect to obtain representative results.

As in the analysis for countries, we shall work out standard index A, which is the average of the ratios $\frac{\text{output per head in region}}{\text{output per head in U.K.}}$ weighted by employment in each trade in the region, as well as standard index B, which is weighted by employment × U.K. output per head and is the ratio of actual to normal average output per head. The results are shown in Table 13, page 216.

As in the analysis for countries, the two standard indices are fairly consistent. They show a favourable picture not only for the London area, but also for the Birmingham area, the East Midlands and—surprisingly enough—for Wales. Among the Scottish regions, output per head is highest in the West but even there lower than in 6–8 out of 11 English regions; the North comes close to N. Ireland, at the bottom of the scale.

The results, especially in the smaller regions like the West Midlands, are subject to the limitations arising from the exclusion of some trades. For England and Wales and for Scotland as a whole, we have already attempted to make allowance for this factor; if we further assume the standard indices in the remaining trades to be the same for each English region and the same for each Scottish region, we obtain the following final estimates, for regions as well as countries (see Table 14, page 216).

The figures for normal output per head show that the wide variations between regions in actual output per head are largely due to differences in industrial structure. Actual output per head is high wherever the region specializes on industries with a high output per head, with the

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TABLE 13

Average output per head in selected trades

Region	*Standard index A*	*Normal value* (£)	*Actual value* (£)	*Standard index B*
England and Wales:				
London area	110·9	254·5	276·4	108·6
North West	95·4	206·4	198·3	96·1
West Riding	97·0	207·8	200·6	96·6
North	87·6	256·6	221·6	86·4
Birmingham area	100·2	220·1	222·8	101·2
East Midlands	100·4	194·0	194·8	100·4
West Midlands	94·6	248·6	230·2	92·6
South	104·9	253·4	261·7	103·3
South West	94·0	256·1	232·3	90·7
East	96·0	251·4	239·7	95·3
Wales	99·0	253·6	255·3	100·7
Scotland:				
West	96·5	222·3	209·1	94·0
East	92·8	211·2	193·2	91·5
South	91·7	197·9	176·7	89·2
North	86·2	199·9	167·9	84·0
N. Ireland	85·7	155·9	128·6	82·5

TABLE 14

Average output per head in all factory trades

Country and Region	*Actual*		*Normal*		*Standard index*	
	Value (£)	*Index* (*U.K.*=100)	*Value* (£)	*Index* (*U.K.*=100)	*A*	*B*
England and Wales:						
London area	276·4	120·6	254·5	111·1	110·8	108·6
North West	199·9	87·2	207·7	90·6	95·5	96·2
West Riding	201·3	87·9	208·2	90·9	97·1	96·7
North	222·1	96·9	252·5	110·2	89·1	88·0
Birmingham area	223·6	97·6	220·6	96·3	100·3	101·4
East Midlands	213·6	93·2	210·8	92·0	100·6	101·3
West Midlands	298·4	130·3	298·7	130·4	98·2	99·9
South	261·8	114·3	252·8	110·4	104·9	103·5
South West	243·8	106·4	263·9	115·2	94·8	92·4
East	253·8	110·8	259·9	113·5	97·3	97·6
Wales	258·8	113·0	254·1	110·9	99·8	101·9
Total England and Wales	232·6	101·5	230·6	100·6	100·8	100·9
Scotland:						
West	216·1	94·3	228·3	99·6	96·7	94·7
East	230·1	100·4	243·8	106·4	94·0	94·4
South	191·9	83·8	209·3	91·4	92;9	91·7
North	205·1	89·5	228·5	99·7	89·2	89·8
Total Scotland	217·5	94·9	231·4	101·0	95·0	94·0
N. Ireland	141·0	61·5	164·9	72·0	87·4	85·5
United Kingdom	229·1	100·0	229·1	100·0	100·0	100·0

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exception of the North of England; here the favourable industrial structure is not reflected in the actual results.

The general picture given by the standard indices, which show much less variation than the actual output figures, is that of relatively high figures in the Southern and Midlands regions, with the exception of the South West, but including Wales. The Scottish regions and the northern parts of England are at a lower level, though above that of N. Ireland. Thus, instead of speaking about differences between England and Scotland, it would seem to be more accurate to speak of differences between South Britain and North Britain.

In 1935, there was a distinct difference in prosperity between South and North Britain. It would therefore seem quite plausible that the regional differences in output per head reflect the differences in economic conditions, through average number of hours worked and other factors. The high indices obtained for Wales and the low indices for South West England remain unexplained. It must be remembered, though, that the results for these regions, as well as the West Midlands, the South of Scotland and the North of Scotland, are based on a comparatively small number of trades, the number of persons employed in which is also comparatively small, either absolutely or relatively to all factory employment covered by the Census. Thus, the results are not as conclusive for these regions as for the rest. In the main regions, the results are as might be expected.

Of course, economic prosperity does not always make for a high, nor depression for a low, output per head. There are also factors working the other way. For example, in a slump the least efficient units in a trade may be closed, and production may concentrate on the more efficient units, so that average productivity actually increases. It appears, however, that these factors in 1935 are outweighed by those favouring the more prosperous regions.

In this section and the preceding one, we have thus obtained two partial explanations for the comparatively low output in Scotland: specialization on low value products within a trade, and a specific factor—perhaps the influence of the depression—operating in Scotland as well as the Northern parts of England. These two explanations may be inter-related. The extremely high output per head figure for the London area may well be due to specialization on more expensive products within a trade; this seems plausible, in view of the somewhat higher level of earnings in London, more so than a higher price level of manufactured goods at factory value would be. Between Great Britain and N. Ireland, differences in price levels appear to be more likely, this, together with specialization on trades and subdivisions of a trade with low value of products, could explain the low output per head in N. Ireland.

IV. *Other Explanations and Conclusions*

So far, this analysis has been concerned with the overall difference in output per head between countries and regions. We shall now, for Scotland in particular, consider separately the industries with a relatively high and those with a relatively low output per head, compared with the corresponding figure for the U.K as a whole. Thus we shall ask what factors are associated with a relatively high or relatively low output.

In the previous study, the connection with average size of establishments (or establishments per 1,000 employees) and proportion of male non-operatives has been noted. Here, we shall also consider average electricity consumption as an additional variable, and all non-operatives as an alternative to male non-operatives. For the 25 selected factory trades in Scotland with an output per head above U.K., and the 60 trades with an output below U.K., we obtain, by the present weighting system, the following results (see Table 15, page 218).

In this table, each of the four variables has been treated in exactly the same way as output has been previously. In each case the actual average has been compared with a normal average, obtained by applying the U.K. ratio of, say, establishments per 000 employees in each industry to the actual employment in Scotland and adding over all the trades considered. The standard indices have been computed in an analogous way.

The table is interpreted as follows: In the 25 trades in which Scotland compares favourably with the rest of the U.K., it has a relatively small number of establishments, a high proportion of total or male non-operatives, and a high electricity consumption. Conversely, in the 60 trades showing unfavourable results employment is spread over a comparatively large number of

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TABLE 15

	Selected trades in Scotland		
	With output per head		
	Above U.K.	*Below U.K.*	*Total*
Average establishments:			
Actual (per 1,000 employees) . .	7·16	10·76	9·96
Normal („ 1,000 „) . .	7·59	10·16	9·59
Standard index A	92·5	104·6	101·9
„ „ B	94·4	105·8	103·8
Average non-operatives:			
Actual (per 1,000 employees) . .	113·0	133·4	128·9
Normal („ 1,000 „) . .	105·3	134·3	127·9
Standard index A	114·2	100·0	103·1
„ „ B	107·3	99·3	100·8
Average male non-operatives:			
Actual (per 1,000 employees) . .	79·8	81·3	81·0
Normal („ 1,000 „) . .	80·5	89·8	87·8
Standard index A	104·4	91·3	94·2
„ „ B	99·2	90·5	92·2
Average electricity consumption:			
Actual (B.T.U.'s per employee) . .	2,735	1,833	2,032
Normal („ „ „) . .	2,910	2,234	2,383
Standard index A	107·8	97·5	99·8
„ „ B	94·0	82·0	85·3

establishments, the proportion of non-operatives, particularly men, is low, and so is electricity consumption. On balance, Scotland has, in the selected trades, a slightly more than normal number of establishments, slightly more non-operatives, though less males among them and apparently less than its share of electricity consumption; in the case of this variate, the index depends very much on the weighting method, since there are very wide variations in electricity consumption between one industry and another.

Thus there appears to be a correlation between output on one hand and number of establishments, total or male non-operatives and electricity consumption on the other hand, each variate being measured in terms of its expected value—expected on the basis of the U.K. figure per employee. We have correlated the ratio $\frac{\text{output per head in Scotland}}{\text{output per head in U.K.}}$ with the corresponding ratios for the other variates, taking Scottish employment weights, and a similar calculation has been made for N. Ireland. The results are as follows:

TABLE 16

Variable	*Correlation between output per head (percentage deviation from expected value) and each other variable in*	
	Scotland	*N. Ireland*
Establishments	−·364	−·327
Total non-operatives . .	+·474	+·275
Male non-operatives . . .	+·509	+·297
Electricity consumption . .	+·331	+·166

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These correlations appear to be significant, although the distributions of the variates may be far from normal, and the precise significance may not be easily ascertained. It is, indeed, possible that the results have been unduly influenced by a few industries with abnormal values of the variates or a very large employment weight.

Nevertheless, a relatively high output per head seems to be associated with a relatively small number of establishments (of larger average size), a relatively high proportion of non-operatives among the employees and a high electricity consumption. The numerical influence of these factors, however, cannot easily be assessed with any great degree of confidence.

In the previous study, it was suggested that the low proportion of non-operatives and the small size of establishments tended to depress output per head and thus productivity in a trade. It seems, however, more doubtful now whether such a causal connection exists; indeed, in the case of non-operatives for example, it may work the other way.

It is also possible that differences in proportion of non-operatives, etc., are associated with specialization within trades. Some support for this view can be found from the following table, considering trades with high and low output per head in the U.K.:

TABLE 17

	Factory trades in which output per head in the U.K. is		*All factory trades*
	Above average	*Below average*	
Number of trades	50	59	109
U.K. employment:			
Total (000)	1,811·5	3,346·1	5,157·6
Per trade	36,230	56,713	47,317
U.K. establishments per 1,000 employees	8·72	9·91	9·49
U.K. non-operatives per 1,000 employees:			
Total	186·5	101·0	131·0
Male	129·7	68·1	89·8
U.K. electricity consumption:			
(B.T.U.'s per employee)	4,231	1,119	2,212

It can be seen that electricity consumption and proportion of non-operatives are considerably higher, and the number of establishments slightly lower, in trades with a high output per head. It seems plausible that the same applies to subdivisions of a trade. Thus, in any one trade, a relatively high output per head in a country, which is associated with a favourable value of one of the factors considered, may well be partly due to specialization within the trade. Thus, no conclusive evidence on these factors can be obtained.

The only conclusion which can be drawn is, in a way, negative. It is often asserted that low productivity is caused by a high number of "unproductive" workers. The present analysis shows that low output per head cannot be due to a high proportion of non-operatives: if anything, this would have the effect of raising the output per head.

Summarizing, we can say that the main result of the analysis has been to show that output per head in factory trades at the 1935 Census was relatively low not only in N. Ireland and Scotland, but also in the Northern parts of England. The relatively high output per head in the South of England and the Midlands appears to be partly due to specialization on high-priced products, partly to longer average working hours or other factors associated with greater economic prosperity. When the results of the 1948 Census of production become available it will be of interest to see whether the relative position of the regions has changed.

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Scottish Farm Wages from 1870 to 1900

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For the latter part of the nineteenth century considerable information on Scottish farm wages is available in the various reports of Royal Commissions and investigating Committees. But while these official documents throw much light on agricultural conditions, their accounts of farm wages are sketchy and deceptive. An average wage which included all types of farm workers was frequently given for a county by witnesses as a matter of opinion, and even where more precise figures were recorded they can seldom be compared with those collected at another date. The material thus made available was summarized by Professor Bowley,* who used interpolation and analogy with English conditions to fill out the inadequate data.

The purpose of this article is to offer a fuller and more detached account of farm wages from 1870 to 1900 for the five north-eastern counties of Scotland: Aberdeen, Kincardine, Banff, Moray and Nairn. The source of these figures is the *Aberdeen Daily Journal* and the *Aberdeen Free Press*, which record the wages offered at the various Feeing Markets (or Hiring Fairs). These markets, it should be noted, were at this time a characteristic feature of agriculture in Scotland and in some parts of northern England. Although the material used is not free from statistical uncertainties it has two great advantages—continuity of record and the separation of the different classes of farm workers.

In the period covered the normal term of employment for the Scottish farm servant was the half year running from Whit-Sunday or Martinmas for the single men, or the full year from Whit-Sunday for the married men. A bargain struck at the hiring fair was clinched by the payment of "arles" varying from 1*s.* to 2*s.* 6*d.*; apart from this token, the wages agreed were normally not paid until the end of the term, though monthly advances might sometimes be allowed. The days of hiring fairs were recognized holidays, then a rare event in the agricultural world, when business was often noisily combined with pleasure.

Feeing markets, however, were not attended by all classes of farm servants, while the composition of the markets changed in some respects during these thirty years. Shepherds, a peculiar sect, were rarely included in these records. Married workers were also to some extent excluded. Where cottages were provided by the farmer a considerable but unknown proportion of married men were either engaged by personal contact outside the machinery of the feeing market or engaged by the year at special Cottar feeing markets, held between February and some six weeks before the term. These markets, since they dealt with annual engagements and were inadequately reported, are outside our scope. The partial exclusion of the married man in so far as he did not hire "single" is not serious, however. Removal for a family man was a more weighty affair than for a bachelor lodged in a bothy or fed in the farm kitchen, and occurred less frequently. His importance is further lessened by the tendency, noted in successive Royal Commissions, for farmers and landowners to build more "bothies" (or "men's houses") rather than to build or keep in repair the costlier cottages needed for married men. In consequence the married men gravitated towards cottages in the village, from whence they hired themselves "single" to local farmers, or undertook day work, or even left agriculture altogether. These facts, therefore, reduced married farm servants to a minority among farm workers. During the 'seventies also the younger age groups of boys recorded in the previous few years were eliminated by the extension of compulsory education, with consequences on the range of wages given for this class of worker. Lastly, fewer and fewer women were to be found at these markets. The steady decline in the number of crofts and the widening range of urban employments reduced the supply of women available for regular farm work, while mechanization of field work and the transference of much dairy work to men gradually reduced the need for them. A rising proportion of those engaged

* *J.R. Statist. Soc.*, 62, 140.

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were also secured through the private registry offices, which protected the more respectable from the rough and tumble of the open feeing market.

The long hiring system induced an unsettled state of mind as "flitting time" approached. The result was a psychological compulsion to move and take a chance of betterment in wages or conditions. The mobility of farm labour must not be overstated however. Estate workers were often treated as permanent retainers; grieves (or bailiffs) moved at comparatively infrequent intervals of, say, half a dozen years; a good man who suited his master and was satisfied with his house might remain when the other workers left. Mobility probably increased during the period. The Richmond Commission commented that "steady men, interested in all the outgoings of the farm and carrying on its operations with care and economy, are not as common as they were thirty years ago."* We do not know the proportion of men who changed their jobs each year, nor the numbers engaged at these hiring fairs, but we can again rely on contemporary opinion for the facts that single men flitted often, and that the engagements made at the hiring fairs were sufficiently numerous to provide an accurate indication of the market rates for the classes frequenting them.

The origins of many of these fairs are unknown, but some fairs declined in importance in these years and others rose. Thus, according to the *Aberdeen Daily Journal*, Banff, Laurencekirk, Forres, New Aberdour and Strathdon were becoming increasingly important, while Elgin, Ellon, Inverurie, Longside, Ballater, Potarch and Peterhead were less popular. In deciding some of the changes local prejudice probably played as large a part as did purely economic reasons. The number attending a market was not the only criterion of importance. The first large fair in each season set the tone for others in the area. Thus Laurencekirk ruled Auchinblae; Aberdeen ruled Stonehaven, Udny and Inverurie; Tarland influenced Strathdon and Kincardine O'Neil; and Forres had effect upon Nairn. Although held fairly late in the season Aberdeen, however, governed most of the other markets, some of them being almost extensions of those held in the city.

Accounts of wages are given for forty-four markets in the five counties specified, from 1870 to 1900. The reporters generally quoted for each market a range of figures such as "First Horsemen, £16–£18," or an average figure, such as "First Horsemen, £17," or fixed the upper or lower limit of the wages offered, such as "First Horsemen up to £18." Clearly this kind of information is not wholly satisfactory. Apart from the errors of estimation, the degree of validity probably varied with the year, the market and the class. The ranges themselves are not always fully comprehensive, sometimes including the exceptionally high or exceptionally low figure, and at other times ignoring the exceptions. The number of markets quoted varies from year to year and from class to class. Where there are less than ten quotations the figures in the tables have been marked with an asterisk. The chief difficulties here lie before 1877, although throughout the period Cattlemen and "Other Males" are less commonly quoted than other classes, and Women and Boys are rather thinly represented in the late 'nineties.

The statistics given below are not without their defects and qualifications, but their division into six classes reveals the interior structure of agricultural wages more clearly than do the official figures. By combining all horsemen from first to fourth (as Horsemen) the official figures produced an average which was deceptively low for the senior first horsemen and Cattlemen.† By limiting all Other Workers to adults they excluded the youths, who often performed the same economic function as adults but who were lower paid; an average was thus given which was deceptively high for this class of worker. Because of these simplifications the Board of Trade Reports made the erroneous claim that there was very little difference between their three categories of farm servants —horsemen, cattlemen and all others. The average agricultural wage compiled by Professor Bowley‡ carried this simplification to its extreme form, thus disguising a complexity which is itself only partially revealed in the following tables.

In the light of possible deficiencies in the material no attempt has been made at a sophisticated statistical analysis. For each class and for each half year straightforward averages of the figures given in the bottom range, in the top range, and of both together have been calculated (referred

* *Report of Mr. Walker to the Royal Commission on Agriculture*, C2778 II (1881), p. 568.

† *Report on the Wages and Earnings of Agricultural Labourers in the United Kingdom*, Cd. 346 (1900), p. 73.

‡ *J.R. Statist. Soc.*, 62, 148.

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to hereafter in the text as the bottom figure, the top figure and the average figure, respectively). The top and bottom figures have been tabulated as ranges (Tables 1 and 2), as in the original newspaper reports. Since halflins (youths of about 16 to 18 years of age) cannot always be separated from the third or fourth horsemen, second cattlemen and orramen (odd-job men) who are the concern of the "Other Males" group, the bottom figure in this group has been divided where necessary to indicate the presence of two distinct levels. The average figure (which includes the "average" quotations of the original reports) has been set out in Table 3.

It might appear simpler if the two sets of figures for the periods beginning on May 28th and on November 28th were combined to give an annual wage. This was not justified by the data, however, for the markets quoted in the two periods would rarely be identical. Further, the wages given are for a specific period of six months, and the succeeding six months reflect different conditions of hiring. Not only was the work dissimilar in the two periods, giving rise to a different level of wages during the two halves of the agricultural year, but farming prospects and labour supply might vary and be reflected at each feeing market. To add the two periods together would lose the distinctions which existed between them, and encourage the impression that the period of natural significance was the Year.

It should be pointed out that all the figures given refer to cash wages which might be appreciably supplemented by the value of perquisites. These were given in the form of accommodation

TABLE 1.—*Ranges of Cash Wages offered at Spring Hiring Fairs in the North East of Scotland,* 1870–1900

The figures are in £'s

Spring	*1st H'man*		*2nd H'man*		*Other Males*			*Cattlemen*		*Boys*		*Women*	
	From	*To*	*From*	*To*	*From (a)*	*From (b)*	*To*	*From*	*To*	*From*	*To*	*From*	*To*
1870	10·5*	11·8*	9·4*	10·6*	..	7·3*	9·4*	9·2*	10·8*	3·6*	6·4*	3·8*	5·4*
1871	10·8	11·9	9·3	10·7	..	7·1	9·0*	9·3*	10·8*	3·3*	5·8*	4·4*	5·5*
1872	11·4	13·1	10·1	11·2	6·3*	8·9*	10·1	9·2*	11·0*	4·1	6·3*	5·2	6·8
1873	12·2	14·3	11·0	12·6	7·0*	8·3	11·0	9·2*	11·0*	4·9	7·6*	5·5	7·5
1874	13·7	15·4	11·5	13·7	8·3*	9·8*	12·5*	10·5*	13·0*	4·5*	7·5*	5·9	7·7
1875	15·1	17·0	13·6	15·1	7·3*	10·8*	13·3	12·5*	14·9*	5·3	8·7	7·1	9·9
1876	17·0	19·0	15·2	17·1	9·7*	10·3*	14·8*	15·2*	17·0*	7·0*	9·4*	7·6	9·9
1877	16·5	18·4	14·6	16·2	8·0*	10·9	14·5	14·2*	17·0*	6·8	9·8	6·9	8·9
1878	16·2	18·1	14·1	16·0	9·0*	9·9*	14·0	13·5*	17·2*	5·8	9·9	6·0	8·8
1879	13·0	15·3	11·2	12·9	5·8*	9·2*	11·5	11·0*	14·7*	5·0	8·9	5·2	6·9
1880	12·1	13·9	10·3	12·0	5·8*	8·3	10·4	9·6*	12·6*	4·2	7·1	5·1	7·1
1881	11·8	13·8	9·6	11·5	..	7·8	9·7	8·6*	11·2*	4·2	6·3	4·9	6·7
1882	12·4	13·9	10·7	12·2	6·0*	8·5	10·7	10·5*	12·4*	4·9	7·8	5·3	7·2
1883	12·8	15·2	11·2	12·8	6·7*	9·3*	11·7	10·4*	14·1*	4·8	8·4	5·6	7·7
1884	13·1	15·6	11·7	13·5	7·5*	9·3	11·9	11·4*	14·4*	5·1	8·1	6·3	8·3
1885	13·1	14·9	11·0	12·5	6·3*	8·9	11·1	11·5*	14·4*	4·6	7·3	6·0	7·9
1886	12·5	14·4	10·4	12·1	..	8·8	10·3	11·0*	14·1*	4·1	7·3	5·7	7·5
1887	11·9	13·2	10·0	11·4	6·3*	7·8	9·9	10·2*	12·3*	4·0	6·3	5·0	7·0
1888	11·0	13·5	9·4	11·0	..	7·9	9·8	9·6*	12·4*	3·6*	6·0	5·0	6·8
1889	11·9	14·6	9·8	11·5	..	8·8	10·4	11·0*	13·7*	3·3*	5·9*	5·3*	7·3*
1890	13·0	14·6	10·7	12·3	6·4*	8·9*	10·6	10·9*	13·3*	4·5	7·0	4·8*	6·9*
1891	13·5	15·4	11·7	13·3	6·8*	9·5	11·4	11·8*	14·2*	4·6	8·0	5·9*	8·4*
1892	15·1	17·0	13·3	14·8	7·9*	11·0	12·9	14·4	16·2	5·7	8·6	6·1	8·1
1893	14·9	16·6	12·3	13·9	7·0*	10·8	12·3	13·1*	14·9*	5·0	8·5	6·9*	8·0*
1894	14·9	16·6	12·6	14·2	9·4*	10·3*	13·1	13·3*	15·6*	5·3	8·5	6·3*	8·3*
1895	15·7	17·0	13·3	14·7	8·0*	9·4*	12·7	14·3*	16·0*	5·0	8·2*	5·6*	8·6*
1896	14·2	16·4	12·3	14·0	7·0*	10·3	12·5	13·5*	16·0*	5·8	8·5	6·6*	8·5*
1897	15·9*	17·6*	13·8*	14·8*	..	11·6*	13·1*	15·3*	17·0*	5·7*	9·8*	6·0*	7·8*
1898	15·3	17·2	13·0	14·7	8·5*	10·5	12·7	13·8*	15·8*	6·1	9·5	6·4*	8·1*
1899	15·6	17·3	13·8	15·5	10·0*	10·9	13·4	15·3*	16·8*	7·1	9·9	..	..
1900	17·3	18·7	15·2	16·8	10·0*	13·1	15·1	15·3*	17·9*	7·8	10·5	..	..

(*a*) Bottom figure of quotations containing haflins as well as orramen or third horsemen within the general range of Other Male Workers.

(*b*) Bottom figure of all quotations of Other Male Workers excluding haflins.

* Less than 10 markets quoting figures for this class.

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TABLE 2.—*Ranges of Cash Wages offered at Autumn Hiring Fairs in the North East of Scotland,* 1870–1900

The figures are in £'s

Autumn	1st H'man		2nd H'man		Other Males			Cattlemen		Boys		Women	
	From	To	From	To	From (a)	From (b)	To	From	To	From	To	From	To
1870	10·4*	11·8*	8·6*	9·9*	..	7·5*	9·2*	9·6*	10·6*	3·3*	6·5*	2·3*	3·2*
1871	10·6*	11·8*	9·0*	10·4*	..	7·3*	9·1*	8·3*	9·8*	3·3*	5·3*	2·6*	3·8*
1872	11·3	12·5	10·1	11·3	6·3*	8·3*	10·2*	9·8*	11·1*	3·6*	6·9*	2·8	4·3
1873	12·6	15·1	10·7	12·6	8·3*	8·6*	11·4	9·9*	11·6*	4·3	7·8*	3·3	5·3
1874	13·4	15·2	11·6	13·0	8·5*	8·7*	11·3*	11·7*	13·4*	5·0	7·7	3·9*	5·9*
1875	15·6	17·2	13·8	15·3	8·0*	10·8*	13·4*	12·5*	15·6*	6·2	9·5	4·7	6·8
1876	15·5	17·2	13·7	15·3	6·0*	10·8	13·6	13·3*	16·8*	6·4	9·9	5·0	7·0
1877	15·7	17·6	13·3	15·4	7·5*	10·3	14·1	14·6*	17·4*	6·5	9·8	4·8	7·0
1878	14·0	15·9	12·1	13·8	7·5*	9·2*	12·6*	11·7*	15·2*	5·5*	8·3*	4·4	6·1
1879	11·4	13·0	9·5	11·0	..	7·8	9·7	9·3*	11·4*	4·3	6·6	3·6	5·5
1880	11·7	13·7	10·0	11·7	6·0*	8·1	10·3	8·9*	12·1*	4·0	7·1	4·1	6·1
1881	11·7	13·7	10·1	11·4	..	8·1	9·6	9·0*	11·4*	4·9	7·3	4·1	6·1
1882	12·5	14·6	10·6	12·4	6·5*	8·2	10·8	10·1*	13·1*	4·4	7·8	4·5	6·2
1883	13·2	15·4	11·6	13·3	6·8*	9·2	11·3	10·7*	13·3*	4·7	7·7	4·6	6·7
1884	12·9	14·7	10·7	12·8	7·0*	8·0	10·4	10·7*	13·8*	4·1	6·7	5·1	6·7
1885	12·6	14·3	10·5	12·0	6·0*	8·5*	10·6*	10·9*	13·0*	4·3*	7·4*	5·0*	6·5*
1886	11·8	13·6	10·3	11·8	6·5*	8·1	10·2	9·5*	12·4	4·3*	7·4	4·9	6·5
1887	11·2	12·8	9·3	10·6	5·1*	7·8*	9·4	9·4	11·6	3·5	5·7	3·8	5·5
1888	11·4	13·4	9·7	11·3	..	8·0	9·9	9·7*	12·6*	4·5	7·0	4·6*	6·3
1889	12·4	14·1	10·7	12·2	6·3*	8·2*	10·5	11·4*	14·0*	4·8	7·4	5·0*	6·8
1890	13·0	14·5	11·2	12·4	6·6*	9·5*	11·0	11·5	14·2	5·4	7·9	5·3*	7·4*
1891	14·5	16·4	12·4	13·7	7·0*	9·5*	12·2*	12·7*	14·8*	5·3	8·9	6·0*	7·8*
1892	13·7	15·7	11·8	13·4	..	10·4	11·9	12·7*	15·3*	5·8	8·8	6·0*	8·0*
1893	13·9	16·0	11·1	13·3	8·2*	9·3*	12·2	13·5	15·4	5·4	8·5	6·4*	7·9*
1894	14·1	16·5	12·3	13·9	8·0*	10·1	12·3	11·7*	15·1*	4·9	8·5	6·3*	8·5*
1895	14·9	16·5	12·1	13·9	7·7*	9·9*	12·3	13·6*	15·8*	5·2	8·4	5·8*	8·3*
1896	14·5	16·3	13·3	14·7	8·0*	9·8	12·2	13·5*	15·8*	5·6*	8·4*	7·5*	9·5*
1897	15·3	16·6	13·6	15·0	9·7*	10·3	12·4	14·0*	16·1*	5·9	9·2	5·0*	9·3*
1898	15·1	16·7	13·2	15·1	8·3*	10·4*	12·7	13·0*	16·5*	6·5	9·5	6·0*	8·1*
1899	16·1	17·8	14·0	15·8	9·0*	12·1	14·3	15·2*	17·7*	6·8	9·7	7·0*	9·2*
1900	16·7	18·5	14·3	16·1	10·2*	12·3*	14·1	15·6*	17·4*	6·4*	10·0	..	..

For notes see foot of Table 1.

with or without full board, potato-land, meal, milk or keep for livestock. Many attempts have been made to estimate the importance of these additions, but no reliable data exist. The local variations, even within this relatively small area, are sufficient to preclude a firm figure. Thus men of the same class, with identical family responsibilities and equal ability, working for the same farmer might obtain different perquisites as a result of individual bargaining. The farmers tended to give way here rather than to grant an increase in the cash wage, which might incite wage claims all round. The real level of earnings might seem to have risen less rapidly than the cash wage because it tended to decline with the general fall in commodity prices, but the cash part steadily purchased more as the century closed. There was also a partial movement towards the payment of cash equivalents, which would help to make the trend in such cash wages approximately that of the probable trend in total earnings.

A number of points emerge from a study of these tables.

1. The same general trend is observable for the first three classes of adult male workers, despite the differences in status among these classes. This similarity makes it permissible in the subsequent examination of this trend to take one category as being indicative of the entire group. The average figure for first horseman is taken for this purpose.

2. This trend comprised (*a*) a rise of approximately 60 per cent. between the Spring wages paid in 1870 and 1876, with somewhat smaller gains over this period in Autumn wages; (*b*) between 1876 and 1881 a fall almost as rapid as the preceding period, but at the lowest point the

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TABLE 3.—*Average of Cash Wages offered at Spring and Autumn Hiring Fairs in the North East of Scotland*, 1870–1900

The figures are in £'s

Year	1st H'man		2nd H'man		Other Males		Cattlemen		Boys		Women	
	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
1870	11·2	11·1	10·0	9·3	8·4	8·4	10·0	10·1*	5·0	5·1	4·6	2·7
1871	11·3	11·2	10·0	9·7	8·0	8·3	10·0*	9·1	4·6	4·2	4·9	3·2
1872	12·3	11·9	10·6	10·7	9·6	9·7	10·4*	10·5	5·0	5·1	5·9	3·5
1873	13·3	13·8	11·8	11·6	9·8	10·3	10·1*	11·2	6 1	5 7	6 6	4 2
1874	14·5	14·3	12·6	12·3	11·7	10·1	11·8*	12·5	5·9	6·3	6·8	4·9
1875	16·1	16·4	14·4	14·5	12·2	12·2	13·7*	14·0*	6·9	7·9	8·7	5·8
1876	18·0	16·4	16·2	14·5	13·0	12·3	16·1	15·0*	8·2	8·0	8·8	6·0
1877	17·4	16·8	15·3	14·4	12·8	12·2	15·6	16·0	8·3	8·1	7·8	5·9
1878	17·2	15·0	15·0	13·0	12·4	11·0	15·4	13·4*	7·7	6·9	7·4	5·3
1879	14·2	12·2	11·9	10·3	10·5	8·7	12·8	10·3	6·7	5·4	6·1	4·5
1880	13·0	12·7	11·1	10·8	9·5	9·3	11·0	10·6	5·6	5·6	6·1	5·1
1881	12·8	12·7	10·5	10·6	8·7	8·9	9·9	10·2	5·2	6·1	5·8	5·0
1882	13·1	13·5	11·5	11·5	9·6	9·7	11·5	11·6	6·3	6·0	6·2	5·4
1883	14·1	14·3	12·0	12·5	10·8	10·4	12·2	12·0	6·6	6·1	6·6	5·7
1884	14·4	13·8	12·6	11·8	10·8	9·3	12·9	12·3*	6·5	5·4	7·4	5·9
1885	14·0	13·5	11·7	11·3	10·2	9·5	12·9	12·2*	6·0	5·8	6·9	5·8
1886	13·4	12·7	11·3	11·0	9·5	9·3	12·6	11·0	5·6	5·7	6·6	5·5
1887	12·6	11·9	10·8	9·9	11·2	10·6	5·2	5·0	5·2	5·0	6·0	4·6
1888	12·2	12·4	10·2	10·5	8·9	9·0	11·0	11·1	4·7	5·7	5·9	5·5
1889	13·2	13·3	10·7	11·4	9·6	9·7	12·4	12·5	4·6	6·1	6·3	5·9
1890	13·8	13·7	11·5	11·8	9·9	10·4	12·9	12·9	5·7	6·6	6·1	6·4
1891	14·4	15·5	12·5	13·0	10·6	10·9	13·0	13·8	6·3	7·0	7·1	6·9
1892	16·1	14·8	14·0	12·7	12·2	11·1	15·3	14·3	7·1	7·3	7·1	6·9
1893	15·8	15·0	13·1	12·2	11·5	11·2	14·0	14·4	6·7	7·0	7·5	7·2
1894	15·8	15·3	13·4	13·1	12·1	11·3	14·5	13·5	6·9	6·7	7·3	7·8
1895	16·4	15·7	14·0	13·0	11·5	11·3	15·1	14·8	6·4	6·8	7·1	7·0
1896	15·4	15·4	13·2	14·0	11·5	11·1	14·7	14·6*	7·1	7·0	7·6	8·5*
1897	16·8	16·0	14·3	14·3	12·3	11·6	16·0*	15·0	7·8	7·5	6·9*	7·3*
1898	16·3	15·9	13·9	14·1	11·8	11·6	14·8	15·0	7·8	8·0	7·3*	7·0*
1899	16·5	17·0	14·7	15·0	12·2	13·3	16·2	16·4	8·5	8·3	8·0*	8·5*
1900	17·9	17·6	16·0	15·2	14·1	13·4	16·7	16·5	9·2	8·3	10·0*	..

* Less than 10 markets quoting figures for this class.

wage was still above that paid in 1870; (*c*) a period of relatively low wages between 1881 and 1887–8 despite a short-lived recovery around 1884, the result of the six years showing a slight reduction in the wage level; (*d*) a period of rapid increase between 1887 to 1888 and 1891 to 1892, and thereafter an undulating but general rise, with the onset of the Boer War stimulating a sharp upward turn, so that by the end of the period the wage level was above that reached in 1876 to 1877, which had represented the highest point reached from 1870 onwards.

3. This analysis in terms of a consistent general trend is not altogether applicable to the cattleman, for whereas in 1870 the cattleman was paid rather less than the second horseman, by 1883 he had overtaken the latter and often challenged the first horseman as the highest paid worker. In some areas (Ellon, Insch and Aberdeen, for instance) he did so successfully. The increase in cattle herds, stimulated by famous pedigree breeding for which Aberdeenshire especially was then renowned and which was quite widely dispersed to even small farms, raised the status of the cattleman so that the phenomenon reflects the technical changes carried out in agriculture in the area. It should be observed, however, that despite this change in relative position, the general pattern of the wage structure of the cattleman follows, in a markedly similar fashion, that of the horsemen.

4. The wages paid to women increased from twice to three times their level in 1870 during the thirty years under review. This was due chiefly to the fact that the demand for women workers increasingly exceeded the supply. The tendency was for "outdoor women" as a class to disappear and for the indoor women to become solely domestics in the 'nineties. As fewer women were

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willing to combine regular work in the fields and milking with housework, the status of those remaining rose. Alternative employment in Aberdeen as domestics or in the textile mills or combworks further increased their bargaining power.

5. It will be observed that the Autumn wage rates tended to be below those offered at the Spring fairs. Two reasons might account for this. Spring engagements were to cover the longer hours needed for summer work, especially harvest, and the men could with justice ask for an increase over the Autumn figure. The second explanatory factor was probably that of differences in the supply of labour. In spring, labour was exported in considerable quantities in three directions—to Angus, Perth and Inverness, where Aberdeen men, who had a comprehensive training in all departments of farm work, were always in demand; to the towns as building labourers, especially in boom times, where strong men used to working without supervision were needed; and to new grain areas abroad where they would be in time for the harvest, this being particularly true of emigrants to Canada at the very end of the period. Labour was therefore rather short in relation to the heavy summer work ahead. Conversely, in autumn, fresh entrants to farming would have come from the schools, and disgruntled emigrants of an earlier year would have returned to swell the supply of labour. Demand, however, especially if work was well forward, might be less for the winter months. The chief deviations from these seasonal tendencies can be accounted for by the superimposition of special tendencies in the shape of rapidly rising or falling wages caused by more immediate factors such as late frosts or heavy harvests.

6. The range between the upper and lower figures in Tables 1 and 2 is apparently unaffected by seasonal differences of labour supply and demand as between the Spring and Autumn hirings. There is, however, some tendency in times of a steep increase in wages for the upper figures to rise more rapidly than the lower figures, thus increasing the range of wages offered. Conversely, in times of a rapid decline in wage level the upper figures tend to fall more rapidly than the lower, thus decreasing the range of wages offered. The weaknesses of the material used preclude any elaborate explanation of this observation.

7. Finally some comparison should be made between these figures recorded in the north-east corner of Scotland and the general trend over a wider area. As previously noted, the existing Scottish averages are not precise enough for this purpose, and those collected by Professor Bowley for Great Britain must therefore be used.* The comparison cannot be detailed for two reasons. Our figures are for cash wages, while Professor Bowley's include the estimated value of perquisites. The second difficulty is in constructing from our material an average wage for the mythical average worker which will match Professor Bowley's average figures. Evidence about the number of workers in different classes is so scanty that a weighted average is out of the question, while a straight average of all wages from a first horseman to a boy has little meaning. It seemed best therefore for the purpose of comparing the trends in north-east Scotland with those of Great Britain, to use the wages in Spring of first horsemen (Table 3) as representative of the general trend in the north-east of Scotland and make no attempt to obtain an average figure.

A study of the two sets reveals that the most noteworthy differences between them are:

(*a*) The existence in the Scottish Series of a marked bump between 1881 and 1888, which is absent in Great Britain. The rise can be explained, at least in part, by the particularly high rate of emigration from the area at this time. The *Aberdeen Journal*, in May, 1882, laments the very extensive scale of emigration, and its detrimental effects on the attendance of men at the fairs. Possibly the subsequent drop to the lower level of 1888 was partly due to the absence of the best and most experienced workers, who had either emigrated or been secured by private bargain.

(*b*) Scottish wages tended to lag some two years behind the fluctuations in the Great Britain series, though the general trends in both are similar. Thus, whereas the figures for Britain reached their highest point in 1874 and their lowest point in 1886, in Scotland the highest point was reached in 1876 to 1877 and the lowest point in 1888.

(*c*) In comparing the two sets of figures, 1880 will be taken as the base year equal to 100—that adopted by Bowley. In order to obtain a consecutive series for Great Britain, two of Bowley's tables have been amalgamated. For the 1870 to 1880 period that given in his article in the

* *J.R. Statist. Soc.*, **62**, 558.

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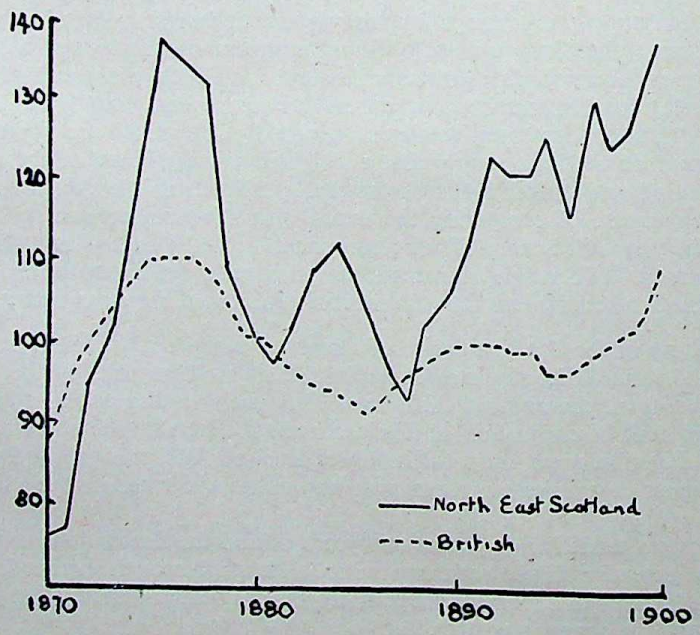
Statistical Journal has been used,* and for the 1880–1900 period that in his "Wages and Income since 1860."† In the former he chose 1892 as the base year, and in the latter 1880, but since both years were equal to 100 the difference between the two series is due only to the statistical method and seldom exceeds 1 point. Wages in Britain only rose from 88 to 110 points from 1870 to 1875, *i.e.*, by 22 points, while in the north-east of Scotland the rise was from 86 in 1870 to 134 in 1876, *i.e.*, a rise of 48 points. Similarly while in the British figures the subsequent trough fell to within 3 points of the 1870 level (1870 = 88; 1886 = 91), in the north-east of Scotland the lowest point in 1888 was 8 points above the 1870 level (1870 = 86; 1888 = 94). Whereas the range in the British figures within the period was at most 21 points, in the Scottish figures it was over 50 points, and while the British figures increased slightly during the period, the Scottish ones increased by approximately one-third.

Although the inclusion of perquisites might have toned down the Scottish figures somewhat, farm wages in the north-east of Scotland seem to have risen substantially over these thirty years, whereas for Britain they remained about the same at the end of the period as they were before. The most likely explanation for the difference is probably to be found in emigration, which was of greater importance in the north-east of Scotland than in most parts of the United Kingdom. The ingrained "loose footed" habits of "flitting" time, the steady surplus of potential farm servants from an area of predominantly small family farms, and the spirit of self-reliance which the local educational system produced, may well account for the greater reduction in labour supply and the consequently higher level of wages in the north-east of Scotland.

* *J.R. Statist. Soc.*, 62, 570.
† p. 8.

COMPARISON OF WAGE TRENDS IN GREAT BRITAIN AND SCOTLAND, 1870–1900. 1880 = 100



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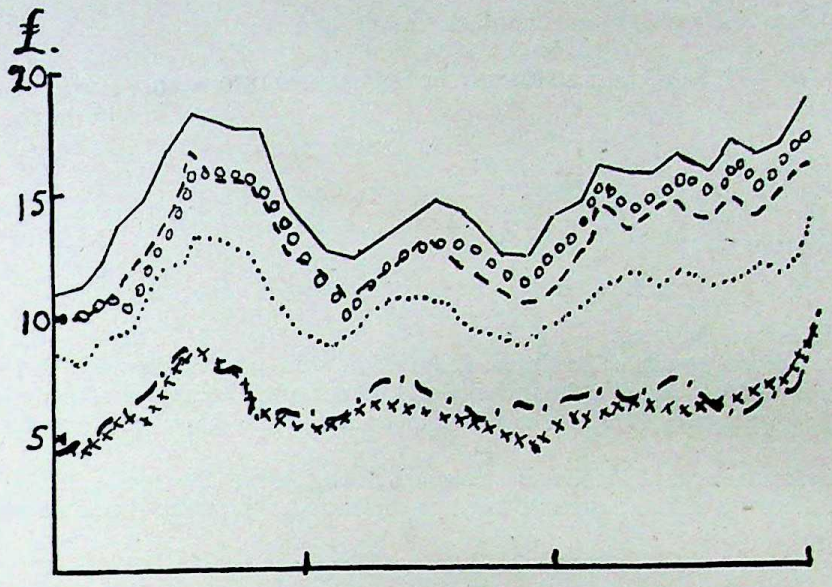
AVERAGE CASH WAGE

Spring



Autumn

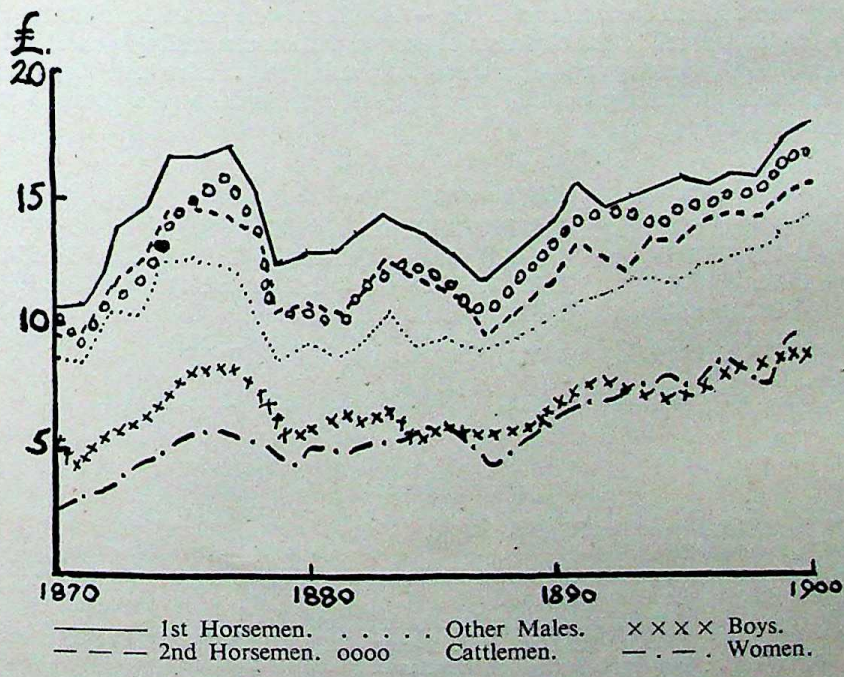


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Table of the Hyperbolic Transformation $\sinh^{-1}\sqrt{x}$

By F. J. Anscombe

(*Statistical Laboratory, Cambridge*)

This table of the function

$$\sinh^{-1}\sqrt{x} \qquad \text{or} \qquad \ln\{\sqrt{x} + \sqrt{(x+1)}\}$$

may be used for two purposes:

(1) To transform counts following a distribution with greater skewness than the Poisson distribution, in order to stabilize the variance and permit of the technique of analysis of variance (Beall, 1942; Anscombe, 1948). x is taken to be a suitable linear function of the observed count.

(2) To normalize a variable following Student's t-distribution (Quenouille, 1950). If t follows Student's distribution with n degrees of freedom, we consider the transformed variable

$$y = \pm \sinh^{-1}\left(\sqrt{\frac{3t^2}{2n}}\right),$$

where the + or − sign is chosen according to the sign of t.* If n is large, y has kurtosis coefficient $\gamma_2 = O(n^{-2})$, as compared with the value $\gamma_2 = 6n^{-1} + O(n^{-2})$ for t itself. Thus for large n, y is approximately normal, and has variance $3/(2n-1)$. It may be noted that all the moments of y are finite, even if n is small. The closeness of approximation can easily be checked by reference to published tables of percentage points of the t-distribution (e.g. Fisher and Yates, 1938). Thus we find the following percentage points (two tails), the approximate value being given first and then the correct value in brackets.

n	50 *per cent.*	20 *per cent.*	5 *per cent.*	1 *per cent.*
2	0·839 (0·816)	1·919 (1·886)	4·017 (4·303)	7·544 (9·925)
5	0·729 (0·727)	1·478 (1·476)	2·536 (2·571)	3·833 (4·032)
10	0·700 (0·700)	1·372 (1·372)	2·220 (2·228)	3·129 (3·169)
20	0·687 (0·687)	1·325 (1·325)	2·084 (2·086)	2·836 (2·845)
30	0·683 (0·683)	1·310 (1·310)	2·041 (2·042)	2·746 (2·750)

The table has been computed by Mrs. E. H. Lawrie, from W.P.A. tables.

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* In the transformation given by Quenouille the factor 3/2 is absent, and the approximate variance of the transformed variable is $1/(n-1)$. The transformation given here is rather more accurate.

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TABLE

The Hyperbolic Transformation

	·00	·01	·02	·03	·04	·05	·06	07	·08	·09
0·0	·000	·100	·141	·172	·199	·222	·243	·262	·279	·296
0·1	·311	·326	·340	·353	·366	·378	·390	·401	·412	·423
0·2	·434	·444	·453	·463	·472	·481	·490	·499	·507	·515
0·3	·523	·531	·539	·547	·554	·562	·569	·576	·583	·590
0·4	·596	·603	·610	·616	·622	·629	·635	·641	·647	·653
0·5	·658	·664	·670	·675	·681	·686	·692	·697	·702	·708
0·6	·713	·718	·723	·728	·733	·738	·742	·747	·752	·756
0·7	·761	·766	·770	·775	·779	·783	·788	·792	·796	·801
0·8	·805	·809	·813	·817	·821	·825	·829	·833	·837	·841
0·9	·845	·848	·852	·856	·860	·863	·867	·871	·874	·878

	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
1·0	·881	·915	·947	·977	1·005	1·032	1·057	1·081	1·104	1·125
2·0	1·146	1·166	1·185	1·204	1·222	1·239	1·256	1·272	1·287	1·302
3·0	1·317	1·331	1·345	1·358	1·372	1·384	1·397	1·409	1·421	1·432
4·0	1·444	1·455	1·466	1·476	1·486	1·497	1·507	1·516	1·526	1·535
5·0	1·544	1·554	1·562	1·571	1·580	1·588	1·596	1·605	1·613	1·621
6·0	1·628	1·636	1·644	1·651	1·658	1·665	1·673	1·680	1·686	1·693
7·0	1·700	1·707	1·713	1·720	1·726	1·732	1·739	1·745	1·751	1·757
8·0	1·763	1·769	1·774	1·780	1·786	1·791	1·797	1·802	1·808	1·813
9·0	1·818	1·824	1·829	1·834	1·839	1·844	1·849	1·854	1·859	1·864

	0	1	2	3	4	5	6	7	8	9
10	1·869	1·914	1·956	1·994	2·030	2·063	2·095	2·124	2·152	2·178
20	2·203	2·227	2·250	2·272	2·292	2·312	2·332	2·350	2·368	2·385
30	2·402	2·418	2·434	2·449	2·464	2·478	2·492	2·505	2·518	2·531
40	2·544	2·556	2·568	2·580	2·591	2·602	2·613	2·623	2·634	2·644
50	2·654	2·664	2·674	2·683	2·692	2·701	2·710	2·719	2·728	2·736
60	2·744	2·753	2·761	2·769	2·776	2·784	2·792	2·799	2·807	2·814
70	2·821	2·828	2·835	2·842	2·849	2·855	2·862	2·868	2·875	2·881
80	2·887	2·893	2·900	2·906	2·912	2·917	2·923	2·929	2·935	2·940
90	2·946	2·951	2·957	2·962	2·967	2·973	2·978	2·983	2·988	2·993
100	2·998	3·003	3·008	3·013	3·018	3·022	3·027	3·032	3·037	3·041
110	3·046	3·050	3·055	3·059	3·063	3·068	3·072	3·076	3·081	3·085
120	3·089	3·093	3·097	3·101	3·105	3·109	3·113	3·117	3·121	3·125
130	3·129	3·133	3·136	3·140	3·144	3·148	3·151	3·155	3·159	3·162
140	3·166	3·169	3·173	3·176	3·180	3·183	3·187	3·190	3·193	3·197
150	3·200	3·203	3·207	3·210	3·213	3·216	3·220	3·223	3·226	3·229
160	3·232	3·235	3·238	3·242	3·245	3·248	3·251	3·254	3·257	3·260
170	3·263	3·265	3·268	3·271	3·274	3·277	3·280	3·283	3·285	3·288
180	3·291	3·294	3·297	3·299	3·302	3·305	3·307	3·310	3·313	3·315
190	3·318	3·321	3·323	3·326	3·328	3·331	3·333	3·336	3·339	3·341

	0	10	20	30	40	50	60	70	80	90
200	3·344	3·368	3·391	3·413	3·435	3·455	3·474	3·493	3·511	3·529
300	3·546	3·562	3·578	3·593	3·608	3·623	3·637	3·651	3·664	3·677
400	3·690	3·702	3·714	3·726	3·737	3·748	3·759	3·770	3·781	3·791
500	3·801	3·811	3·821	3·830	3·839	3·849	3·858	3·866	3·875	3·884

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The Sources and Nature of Statistical Information in Special Fields of Statistics

United Kingdom Brewing Industry Statistics

By L. McMullen

Scope of the Title

The object of this paper is to provide a guide to such statistics as are available in official and other publications. It is not itself intended as a source of statistics, those given being illustrative and incidental.

The brewing industry could be defined in various ways, for the actual range of operations carried out by brewing firms varies considerably. On the raw material side they may buy malt and hops, or they may buy barley and make their own malt, or they may own a hop farm, while on the distributing side they may sell beer in cask to a bottler, or sell bottled beer to a retailer or sell direct to the consumer in their own public house. In these latter they also sell wines, spirits, soft drinks, tobacco and other things not the product of a brewery; so if the brewing industry were taken to cover all forms of activity carried on by firms of brewers it would be a subject with almost unlimited ramifications, and it would be impossible to stop at any reasonably meaningful point. I therefore confine myself generally to what may be regarded as the essential functions of a brewery, the taking in of malt, sugar, hops and water and the conversion of these into beer which is then sold, but as will be seen later, certain statistics are published in a form which forces me outside these limits.

The statistics relating to the Brewing Industry may then be grouped under four heads:

(1) Plant.
(2) Materials.
(3) Personnel.
(4) Finance.

The last of these is not dealt with in this paper.

Section I: Plant

Statistics of Brewing Plant

Brewing was originally an almost domestic craft carried on mainly by women, hence the feminine designations Maltster, Brewster. Later it tended to be done by commercial brewers, but on a small scale for very local consumption; the modern tendency towards large breweries, selling over a wide territory, is of course dependent on an efficient transport system. Even to-day the trade is much more local in basis than probably any other manufacturing industry, as will be seen in the statistics giving the geographical distribution of breweries. The following are some of the reasons for this:

(1) The transport of beer, which is perishable, and liable to spoiling in extremes of temperature, has to be in an expensive container and includes a large amount of water and so is necessarily much more expensive than the transport of its raw materials.

(2) The character of beers before the days of treating water depended largely on the local water, and in general the population has a fairly stable taste for its local type of beer, which varies a good deal in different parts of the country.

(3) The tied house system favours the local brewery.

(4) The retailing of beer needs a lot of supervision by the brewer if consistently good results are to be obtained. Only the largest breweries can afford an organization to do this over a very wide territory.

The modern tendency for industry to concentrate in a few large units is, of course, to be found in brewing, but for the reasons given above it has recently tended to take the form of the larger

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companies buying up smaller breweries and running them as subsidiaries with their own local management.

From the *Customs and Excise Reports** may be seen the number of licences issued for Brewers for sale. This number refers to individual premises, several of which may be included in what is ordinarily considered to be one brewery.

These figures are not in themselves of any great interest, for they do not give any information about changes in the brewing capacity of the country as a whole. Even if the information were available there could be no simple answer to the question of what is the total capacity; for any given brewery can always brew more for a short period than it could keep up indefinitely.

The *Brewers' Almanack*† gives a list of all breweries and their location, and from this I have compiled the following geographical list (Table 1), breweries in the same town under the same immediate ownership counting as one. The numbers are, as expected, considerably less than those for Excise Licences.

Two facts about this table and that previously referred to may be taken as certain:

(1) The range of size is very great, the ratio of size between the largest and smallest being at least 500 to 1.

(2) The reduction in the number of breweries has been almost entirely caused by the closing down of small ones, so that it represents a much less than proportional reduction in total capacity.

In a general way the figures follow the population but note the small number for London. Though these are on the whole large breweries, London is on balance a considerable importer of beer and the suburbs tend to be supplied by breweries further out rather than in the town as at other places.

The only real brewing town is Burton-on-Trent; this originated in its water, which contains a lot of gypsum and is very suitable for brewing pale ales.

Although the number of breweries in Scotland is not unduly small, the larger ones send a lot of beer to England and export it, and it is known that the consumption of beer per head in Scotland is much smaller than in England, though no official figures are available to support this statement.

Section II: Materials

In order to be able to follow statistics relating to brewing, a certain familiarity with the process and terms used to describe them is necessary. The following account may be regarded as the bare minimum which must be grasped in order to realize what the various figures mean. Times, temperatures and other details are to be regarded as typical only.

The basic raw materials of brewing are malt, hops and water.

Malt is made from barley in a malthouse. The process of malting is divided into steeping, flooring and kilning.

Steeping consists of soaking barley in cold water for about 48 hours.

Flooring.—The steeped barley is spread on a floor, where it germinates and ultimately dies, the whole taking about ten days. The cell walls in the corns are broken down rendering the starch accessible to the action of diastase and water. Open flooring is not now much used outside the British Isles, various forms of enclosure being favoured elsewhere in this part of the process.

Kilning.—The "green" malt from the floor is placed on a kiln, of which the floor consists of perforated bricks, and dried by passage of furnace gases to a moisture of about 2½ per cent. in about 72 hours.

The most important function of malt is to provide starch for conversion into sugar, and this is often partially short-circuited by the direct use of sugar in brewing. In addition many other starchy substances, such as flaked maize or unmalted barley, are used as partial substitutes for malt for various reasons such as their availability, low nitrogen or low price. For dark beers and stouts roast barley, roast malt or caramel is added.

* *nth Report of the Commissioners of His Majesty's Customs and Excise for the Year Ended March 31st*, 1909 + n. Table 92 in 1949 Report.

† *The Brewers' Almanack*, published by the Brewers' Society, usually annually.

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TABLE 1

Active Brewers with an Output of 1,000 *Barrels or More Per Annum*

	1906	1913	1924	1930	1937	1946	1949
Bedford	12	11	9	5	5	4	3
Berks	31	26	16	10	6	6	6
Buckingham	14	12	7	3	3	2	2
Cambs	23	21	15	10	6	6	6
Cheshire	24	21	15	10	8	7	7
Cornwall	10	8	6	6	5	4	4
Cumberland	16	15	11	8	6	6	6
Derby	17	13	9	7	4	4	4
Devon	42	36	23	14	10	10	10
Dorset	16	13	13	9	9	8	8
Durham	27	25	20	13	9	8	8
Essex	40	37	30	16	12	10	9
Gloucester	28	22	14	11	7	6	6
Hants	58	46	31	21	16	14	15
Hereford	4	6	6	2	3	3	2
Herts	34	27	16	14	12	8	8
Hunts	8	7	2	2	2	2	2
Kent	51	37	27	19	16	16	16
Lancs	163	128	116	71	67	63	63
Leicester	14	11	8	4	4	5	4
Lincs	32	26	19	11	9	9	9
London	65	53	35	20	20	20	20
Middlesex	13	10	4	3	3	2	2
Norfolk	18	13	11	5	6	8	7
Northants	16	12	10	9	8	7	6
Northumberland	17	15	9	9	9	5	6
Notts	14	14	11	10	10	9	9
Oxford	16	14	9	7	7	6	6
Rutland	2	2	1	1	1	1	1
Salop	18	14	10	6	5	7	6
Somerset	31	26	18	15	14	11	11
Staffs	53	65	52	32	26	24	23
Suffolk	24	19	11	7	5	5	7
Surrey	27	21	12	7	6	4	4
Sussex	43	34	19	11	11	8	8
Warwick	34	25	15	11	11	10	10
Westmorland	4	6	4	2	2	2	2
Wilts	37	30	17	10	7	4	4
Worcester	22	27	19	10	7	6	5
Yorkshire	123	101	81	64	55	53	50
Total, England	1,241	1,049	761	505	432	393	385
Wales (including Monmouth)	81	67	53	38	32	25	26
Scotland	92	65	47	39	40	34	34
Northern Ireland	4	4	3	1	1	1	1
Total, United Kingdom, excluding I.O.M. and Channel Islands	1,418	1,185	864	583	505	453	446

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Hops.—After picking these are dried by kilning and then compressed into bags. In England the bags are cylindrical and called "pockets" and are about 200 lb. each. Abroad they are rectangular bales and often much larger. Price is usually per cwt. Hop concentrates and extracts are sometimes used in place of fresh hops.

Water.—All that need be said here is that the total water consumption of a brewery is usually of the order of six to ten times its output of beer.

Brewing.—Having assembled our materials we now consider the bare bones of the brewing process, which again may be divided into three parts, mashing, hopping and fermenting.

Mashing.—The malt, having been ground, is mixed with hot water and allowed to stand for over an hour at about 155° F. or 68° C., during which the starch is largely converted to sugar by the action of the diastase. The sugar and other substances are then washed out by the addition of more hot water, the resultant liquid being known as unhopped wort.

Hopping.—The unhopped wort is run into a copper and boiled with hops under little or no pressure for an hour or two. It might be mentioned here that hops are used in another way, namely, putting them in cask with finished beer, especially if it is to be sold on draught; this is called "dry-hopping."

Fermenting.—The hopped wort is cooled to about 60° F. or 15° C. and yeast is added; the yeast being in general obtained from a previous brew. The beer is fermented, the sugar being converted into nearly equal weights of alcohol and carbon dioxide. This takes a time from about 3 to 7 days.

These three processes are fundamental, all others are auxiliary and need not be considered here.

All official statistics are given inclusively in terms of beer, although this liquid is divided into three main categories, i.e.

> Ale, a pale or light brown beer.
> Stout or Porter, a dark brown beer coloured with roast barley, roast malt or caramel.
> Lager, a beer fermented slowly at a low temperature by a bottom yeast, as opposed to top yeast used in ale and stout.

Owing to the inclusive nature of the official statistics on the subject the exact distribution of the total trade between these categories is unknown, but it is certain that Ale includes a large majority of the trade, and that very much more Stout is consumed than Lager.

We now come to the two important units, bulk barrels and standard barrels. A bulk barrel is simply 36 imperial gallons. To understand a standard barrel it is necessary to consider how the strength of beer is measured. For Customs and Excise purposes the beer is declared at a given original gravity which may be loosely defined as the gravity the wort had before it started fermenting, and is determined by distillation of the alcohol together with measurement of the specific gravity of the undistilled residue, all according to a standard procedure. The scale is measured from the specific gravity of water taken as 1000, so that a beer may be said to have an original gravity of e.g. 1045 (colloquially forty-five). A standard barrel is 36 gallons or one bulk barrel at original gravity 1055, or the same quantity of substance at any other gravity, e.g. half a bulk barrel at 1110 or 1·25 bulk barrels at 1044.

We thus have the relation

$$S = \frac{BG}{55} \text{ when } S = \text{standard barrels, } B = \text{bulk barrels, } G = \text{original gravity} - 1000.$$

It may be noted that the standard barrel differs fundamentally from the corresponding unit for spirits, the proof gallon, in not being based on the alcohol content of the beer. This content is a function of the degrees fermented (original gravity minus present gravity) and, to a close approximation per cent., alcohol by weight is one-tenth of degrees fermented; thus a beer of original gravity 1055 would have 4 per cent. of alcohol if it had fermented to a specific gravity of 1015, and 4½ per cent., if it had reached 1010. A naturally conditioned beer continues to ferment until consumed, which explains the impossibility of any statistic based on alcohol content.

The beer duty.—The beer duty was first imposed in 1660 at the rate of 4*s.* 9*d.* per barrel for strong beer and 1*s.* 3*d.* for weak beer. It underwent many vicissitudes in the following 220 years,

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sometimes being partially or totally converted into a malt tax and a hop tax, but the modern history of the beer duty begins from Mr. Gladstone's budget for 1880, when the standard barrel was introduced as a basis for taxation; at that time the standard barrel was 1057°. In 1889 it was reduced to 1055°.

The duty remained comparatively small until the first world war, being 7*s.* 9*d.* per standard barrel in 1914. After this it was rapidly increased, both in order to raise revenue and to keep consumption in check.

In 1933 the system was changed and since then the standard barrel has no longer been used as a basis; instead there was a minimum duty of 24*s.* per barrel at 1027, beers below this paying the same, and an increase of 2*s.* per barrel for each degree above 1027. Except for beers below 1027 this is exactly equivalent to a duty of 110*s.* per standard barrel, with a rebate of 30*s.* per bulk barrel, and in Table 2 I have shown all the newer duties on the older basis as well. The total increases during and after the second war range from four to over seven times, and it will be seen that in 1948 the duty on a moderate gravity beer (1041) was nearly 1*s.* per pint (there are 288 pints in a barrel). This explains why in spite of the great technical advances made in brewing since 1914 it is now not possible to get good beer at a reasonable price.

TABLE 2

The Beer Duty, 1914–1949*

On standard barrel basis throughout. From 1933 on there is no reduction for beer below 1027 and the column for that gravity is a minimum.

Date	*Rate per standard barrel*	*Rebate per bulk barrel*	*Duty per barrel at gravities of*			*Increase per degree*
			1027	1041	1055	
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
April, 1914	7 9	Nil	3 9½	5 9½	7 9	1·7
Nov., 1914	23 0	,,	11 3½	17 1½	23 0	5
March, 1916	24 0	,,	11 9½	17 10½	24 0	5
,, 1917	25 0	,,	12 3½	18 7½	25 0	5½
April, 1918	50 0	,,	24 6½	37 3½	50 0	11
,, 1919	70 0	,,	34 4½	52 2	70 0	1 3
,, 1920	100 0	,,	49 1	74 6½	100 0	1 10
,, 1923	100 0	20 0	29 1	54 6½	80 0	1 10
,, 1930	103 0	20 0	30 7	56 9½	83 0	1 10½
Sept., 1931	134 0	20 0	45 9½	79 10½	114 0	2 5
April, 1933	110 0	30 0	24 0	52 0	80 0	2 0
Sept., 1939	110 0	6 0	48 0	76 0	104 0	2 0
April, 1940	137 6	2 6	65 0	100 0	135 0	2 6
July, 1940	165 0	Nil	81 0	123 0	165 0	3 0
April, 1942	240 7½	,,	118 1½	179 4½	240 7½	4 4½
,, 1943	281 10½	,,	138 4½	210 1½	281 10½	5 1½
,, 1944	286 5½	,,	140 7½	213 6½	286 5½	5 2½
Nov., 1947	325 5	,,	159 9	242 7	325 5	5 11
April, 1948	364 4½	,,	178 10½	271 7½	364 4½	6 7½
,, 1949	364 4½	21 0	157 10½	250 7½	343 4½	6 7½

* *Note.*—April, 1950. Minimum duty for beers of 1030 or lower, 155*s.* 4½*d.*, increase per degree 6*s.* 7½*d.* (unchanged). This is equivalent for beers of 1030 and above to a rate of 364*s.* 4½*d.* per Standard barrel (unchanged) with a rebate of 43*s.* 1½*d.* per bulk barrel. The change of duty has been accompanied by an agreement by which all beers are to be increased in gravity by three degrees, and it may be seen from the above that they will then pay 2*s.* 6*d.* less duty per barrel than they did at the former gravity.

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The duty is charged on beer in fermenting vessel shortly after filling. An allowance of 6 per cent. is made for waste during and after fermentation.

In addition to the restrictive influence of the duty the gravity of beer is at present kept down by direct restrictions on the average gravity of any one brewer's output, but it is hoped that these are of a sufficiently temporary nature not to merit inclusion in this paper.

Statistics relating to this section may be found as follows:

Materials used in brewing.—Table 32, *Customs and Excise Reports.** The figures are given in cwt. The usual custom of the trade is to speak of quarters of both barley and malt, a quarter of barley being 448 lb. and of malt 336 lb. These amounts are roughly equivalent, for in malting barley loses about 15 per cent. of its weight of moisture and 10 per cent. of dry matter. Owing to the use of malt substitutes it is not possible to deduce from the table the relation between quantities of malt and standard barrels, but it may be taken that a quarter of malt of average quality would be equivalent to 4·7 standard barrels of beer.

The figures for hops used are probably not quite accurate. Brewers are required to declare to the Excise the number of pounds of hops used in each brew, but it is believed that there is some variation of practice as to whether hops for dry-hopping (see above) are included in this return.

*Beer brewed (bulk and standard barrels) and duty paid.—Customs and Excise Reports,** Tables 27, 28 and 29.

Strong beers were usually brewed in the winter and kept for some months, but this practice is now very restricted, and there is considered to be no great inaccuracy in assuming that the consumption of beer in any period is substantially the same as the beer brewed in it.

Imports and exports.—Figures relating to these are found in the *Customs and Excise Reports* and also in Accounts relating to Trade and Navigation of United Kingdom.

There are several snags which may cause the unwary to draw false conclusions from the crude figures. There has for very many years been a lot of stout imported from Southern Ireland. When that country ceased to be part of the United Kingdom (for revenue purposes, financial year, 1923/24) a large apparent increase in imports took place. Later, since 1936, a proportion of this stout has been brewed in London, causing the imports to decrease again. Apart from Irish stout the imports have consisted mostly of lager type beers from Denmark, Holland and formerly Germany. On imports from non-Empire countries other than Ireland there is an additional import duty of £1 per bulk barrel.

Exports have never been other than a very small fraction of the home consumption, and have mainly gone to British dependencies overseas.

TABLE 3

Recent Figures, Rounded to Three Significant Figures, Showing Order of Magnitude of the Quantities Discussed in this Section

Materials used in brewing, year ended September 30th, 1948	*cwt.*
Malt	9,500,000
Unmalted corn and other malt adjuncts	677,000
Sugar	1,440,000
Hops	231,000
Beer brewed for home consumption, year ended March 31st, 1949	
Bulk barrels	27,000,000
Standard barrels	16,400,000
Duty paid	£295,000,000
Exports and Imports, year ended March 31st, 1949 (bulk barrels)	
Exports (excluding beer for H.M. Forces overseas)	222,000
Imports	876,000

* The numbers of tables in the *Customs and Excise Reports* refer to the 1949 issue.

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Section III: Employment

It is not possible to give figures for employment applicable to exactly the same field as that covered in the preceding sections. The few statistics which are available give figures for those employed in brewing and malting; malt is, of course, used not only in brewing but also for whisky, malt extract and other products. It would not in any case be possible to separate brewing and malting labour completely, for very many breweries have maltings attached to them, and it is usual to employ men from the maltings in the brewery during the summer, when malting is not normally carried on.

Having, therefore, no alternative I give the following sources for statistics of employment in brewing and malting.

(1) Censuses of Production, 1907, 1912, 1924, 1930 and 1935.

These give the total number of people employed in brewing and malting—divided:

(1) into wage-earners and salaried workers;
(2) by sex;
(3) into ages over 18, and under 18;
(4) into England and Wales, Scotland, and Northern Ireland.

The whole of Ireland is, of course, included in the 1907 and 1912 reports.

There is also a table giving numbers employed in one month of each year to show the seasonal variation. Readers are cautioned against assuming that the distribution of brewing between England and Wales, Scotland and Northern Ireland can be approximately obtained from these tables, for in the two latter countries non-brewing malting would undoubtedly be much higher in proportion.

(2) From March, 1949, onward the *Ministry of Labour Gazette* gives monthly figures of those employed in brewing and malting, some 1948 figures being given incidentally. These are divided by sex but in no other way.

Unemployment.—The *Ministry of Labour Gazette* gives unemployment figures in drink industries from July, 1923, to September, 1940, and from November, 1945, to July, 1948. From August, 1948, unemployment in brewing and malting is given.

Labour turnover.—This has been given in the *Ministry of Labour Gazette* since October, 1948, and the issue for that month contains a note explaining the exact scope of the figures.

The following figures may also be of interest:

Number of individuals who are directors of Brewery Companies . . 1,776
(From *Brewers' Almanack*, 1949.)
Number of people employed as technical Brewers 1,099
(From *Incorporated Brewers' Guild Directory*, 1948–49.)
77 names are common to above lists.

Recent figures to show order of magnitude of numbers involved.

Numbers employed in brewing and malting, May 1949: Male, 74,900
Female, 19,200
Total, 94,100

Miscellaneous Notes

Northern Ireland needs a few words in explanation of its special position. It is not a great beer-drinking country for the consumption per head is much less than in the rest of Ireland, which is, in turn, considerably less than that of Great Britain.

The amount of beer brewed in Northern Ireland is not published, presumably because there is only one brewery there.* The amount of beer imported from Great Britain is not published either, nor is the amount sent in from Eire, though this last is certainly the preponderant source of supply.

The duty is the same as in Great Britain.

* It is now closed (March, 1950).

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Isle of Man.—There are two breweries. The duty is at present 81*s.* per standard barrel on Manx brewed and 94*s.* per standard barrel on imported beer.

Channel Islands.—Jersey: One brewery. Customs and Excise duty 46*s.* 3*d.* per standard barrel.

Guernsey: Two breweries. Customs and Excise duty 55*s.* 6*d.* per bulk barrel irrespective of gravity.

Comparison with other countries.—It is outside the scope of this paper to deal in any detail with brewing statistics in other countries, but for the benefit of those who may wish to make comparisons a brief note on the problems involved may be useful.

The only country where exactly the same units and the same system of taxation are used is Southern Ireland; elsewhere the units of measurement and the systems of taxation are in general quite different, while the strength of beer is also measured in many different ways. For example, taxation may be independent of strength (U.S.A.), dependent on strength measured in a few broad classes, as in Sweden, or based on malt used, as in Canada. In Federal countries such as U.S.A., Canada or Australia there is usually a Federal and also a State or Provincial tax, which is often calculated on a different basis. As far as units of volume are concerned, the metric system presents no difficulty, but the American one is very tricky, ounces, pints, gallons and barrels all being different from ours, and, except for pints and gallons, no two in the same proportion. An American barrel is 31 U.S. gallons and is equal to ·7169 of our 36-gallon barrel, or 25·81 imperial gallons. A Canadian barrel is 25 imperial gallons.

In countries where brewing is an important industry there is usually a publication corresponding to our *Brewers' Almanack*, and this should, if possible, be consulted before wading into government statistics; e.g. U.S.A., *Brewers' Almanac*, issued by U.S. Brewers' Foundation, 21, East 40th St., New York, and *Facts on the Brewing Industry in Canada*, issued by Dominion Brewers' Association, Ottawa.

In conclusion I should like to thank all those who have helped in the preparation of this paper, especially Mr. John Byrne and Miss S. V. Cunliffe, and also to thank the Directors of A. Guinness, Son & Co., Ltd., for permission to publish it.

Appendix

List of Sources of Statistics

The Brewers' Almanack.—Normally issued annually by the Brewers' Society. This book, which is extremely well written and arranged, contains an enormous amount of statistics and information about the brewing industry and allied trades. Owing to its much fuller explanations it should be consulted even in cases where figures have to be confirmed from an official source.

nth Report of the Commissioners of H.M. Customs and Excise for the Year Ended March 31*st*, 1909 + n. H.M.S.O. (Present price 3*s.*)

Accounts Relating to Trade and Navigation of the United Kingdom. H.M.S.O. 6*s.* 6*d.* monthly.

Ministry of Labour Gazette. H.M.S.O. 9*d.* monthly.

For older employment figures: *Reports of Census of Production.* 1st census 1907, 2nd census 1912, 3rd census 1924, 4th census 1930, 5th census 1935.

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The Sources and Nature of Statistical Information in Special Fields of Statistics

A Guide to Co-operative Statistics

By J. A. Hough

There are two main sources of reference to the statistics of co-operative societies representing two separate collections and compilations. One source is the reports of the Registry of Friendly Societies; the other is the reports of the Co-operative Union* Congress, which are published annually. The statistics prepared by the Registry of Friendly Societies cover in total for Great Britain the assets and liabilities and main activities of the various types of co-operative society, including distributive and productive and agricultural. The reports of the Co-operative Union cover the same total information except for the agricultural co-operative societies, and they also include the distributive co-operative societies in the whole of Ireland. The Co-operative Union reports, however, as distinct from the reports of the Registrar, are in great detail, and show the statistics of each individual society as well as the group totals. They are also divided according to the Co-operative Union geographical areas. In the appendix a detailed summary of the statistics of various types of society in 1948 is given. The following notes are descriptive of, and based on, the statistics published in the Co-operative Union reports.

In the first place, however, before proceeding to deal with the statistics of co-operative societies, it is advisable to say something briefly about the structure of the Co-operative Movement. The basis is the individual membership of the retail distributive societies. The retail societies pursue two different types of federation. In one type they are joined together to constitute the co-operative wholesale societies, and in the other type they pursue, in a number of instances, a method of local federation on a district or area basis in such trades as dairies, laundries, bakeries, etc. These local federations, representing groups of distributive or consumer societies, stand side by side with the larger retail society, which, on its own, and as part of its direct activities, may engage in similar trades, viz. dairies, laundries, baking, etc. The productive activities of the Co-operative Movement are again in two separate parts. In the first place there are the large productive enterprises of the consumers' societies represented in the main by the productive works of the co-operative wholesale societies. Alongside these activities there are the co-operative co-partnership productive societies, and certain other co-operative productive societies (not co-partnership) which are very similar in structure to the local federations mentioned above.

The point to note is that the fundamental basis of the Co-operative Movement is the retail society, but as one co-operative society may invest capital in another co-operative society to an unlimited amount, the retail societies become shareholders in the wholesale societies and the local federal societies, and also in these days contribute quite largely to the capital funds of the co-operative co-partnership societies in addition to the workers' shareholding in the latter societies. It is necessary to bear these points in mind about the structure of the Co-operative Movement in order that the statistics of co-operative societies may be correctly interpreted.

Membership

The membership figures of retail distributive societies in the aggregate have increased consistently in every year of the present century with the exception of the year 1922, when there was a decrease of 29,395 on the previous year due to the readjustment and amendment of members' registers following the first world war. The growth in the aggregate membership figures during the century has been relatively rapid, for the figures have grown from 1,793,167 in 1901 to

* The Co-operative Union Limited, Holyoake House, Hanover Street, Manchester, 4, is a non-trading federation of co-operative societies, which acts for them in an advisory manner. In addition to the Annual Statistics a regular series of statistical articles is published in its monthly journal, *The Co-operative Review* covering such matters as ration registrations, shops, investments, etc.

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10,162,299 in 1948. The percentage increase from year to year has varied, but even in recent years, and thus on a relatively high base, an annual increase of 2 to 3 per cent. on the previous year has normally occurred. Inside the figures of annual net change in membership there is a substantial proportion of members joining or leaving societies. An analysis of these figures for the years 1928 to 1945 is available.*

The above figures are the shareholding membership figures of retail societies. It is not known precisely what these figures represent in the way of consumers or households in relation to the departmental trade of co-operative societies, although some light is thrown on this aspect of the matter in the statistics of ration registrations. Co-operative societies hold about, or slightly more than, one-quarter of the national ration registrations; e.g. 13 millions in sugar and milk. It is known, however, that all members are not purchasing members. There are a number of reasons for this. In the first place several members of one family may be members of the same society and, of course, this multiplication of the number of members does not increase the trade potential of the family, which may be centralized in one member. In the second place persons may be members of more than one society, and quite a number of persons are members of at least two societies, particularly in those cases where in a town or city there are two co-operative societies operating. Again, older members may have ceased to purchase on their own account, and their trade may be transacted under the membership of some relative. This often applies in the case of retired people.

The proportion of non-purchasing members varies from society to society, and it is not possible to estimate the effect on the aggregate membership figure for all societies. It may be 10 or 20 per cent. of the total membership. Unfortunately, however, there is no common rule which determines the manner in which a society assesses its secondary figure of trading members. The assessment of the number of "trading" members may not be on the basis of members who do no trade whatsoever, but may be on a variable basis differing from society to society such as, for example, by not counting those members who in any trading period, of a quarter or half-year, have not made purchases in excess of, say, five shillings or ten shillings.

It will be appreciated that the shareholding membership figure is the important figure, because retail societies, in addition to their trading operations, act as the repository for members' savings, and on account of the fact that the share capital of societies is almost entirely withdrawable capital, societies tend to act as a kind of unofficial savings bank for members. Thus, the financial aspects of the work of a co-operative society in this manner must be regarded as of particular importance, and the shareholding membership figure is the figure which must be used in estimating the growth and development of co-operative societies.

Retail Distributive Societies

The above membership figures represent the aggregate membership of 1,030 separate societies at the end of 1948. These societies, registered as Industrial and Provident Societies, are all of exactly the same structure and governed in exactly the same way. They vary very greatly in size, however. At the end of 1948 there were eight societies with over 100,000 members each, the four largest of which were as follows: London, 936,501; Royal Arsenal, 338,255; Birmingham, 270,381, and South Suburban, 223,528. At the other end of the scale there were 264 societies with less than 1,000 members each. Very largely the growth of co-operative societies has followed the map, and the large societies are found in the cities and heavily populated areas, whilst the smaller societies are found in the rural areas and villages.

The peak year for the number of societies was 1903, when there were 1,455 separate societies. The reduction in the number of societies since that time has been due in the main to the amalgamation of societies or the transfer of engagements of one society to another. To a great extent, however, this process of integration has not been followed through on an entirely voluntary basis, but in many instances has been forced by the pressure of economic circumstances. No new retail societies representing absolutely new areas have been formed for a number of years, possibly not since the early years of the century.

It should be added that from a purely technical point of view there were, at the end of 1948, forty more retail co-operative societies than the figure stated above, because, in the last few years,

* *Co-operative Retailing* (Co-operative Union).

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in order to meet certain legal requirements, a number of societies have formed, from themselves, separate subsidiary societies for pharmacy. Thus in 1948 there were forty such societies in addition to the 1,030 societies stated above, but in each case, whilst in a legal sense the pharmacy societies are entirely independent societies, in practice they are subsidiary societies of the larger parent societies, and for practical purposes, the best figure to use is the number of parent societies, as stated above.

It is these retail societies which are responsible for the retail distributive activities of the Co-operative Movement, and which constitute the membership of the national and local federations. These retail societies also undertake certain productive and service activities of their own of the kind which in the main are ancillary to retail distribution.

A development in the last twenty years or so has been for the two wholesale societies themselves to engage in retail distribution. There is a difference, however, in this practice as between England and Scotland. In the case of the C.W.S. operating in England and Wales a national society, viz., the C.W.S. Retail Co-operative Society, has actually taken over 24 existing retail societies in England and Wales. These societies, however, are still counted as separate retail societies in the Co-operative Union statistics. In Scotland the S.C.W.S. has pursued a policy of opening retail branches in co-operatively undeveloped areas, and grouping them on an area basis. At the end of 1948 there were 129 such branches in Scotland grouped into 15 areas, each area being shown in the Co-operative Union statistics as though it were a separate retail society.

TABLE 1

Retail Societies—Membership, Shares, Loans

	Number of Retail Societies	*Number of Members*	*Shares*	*Loans*
			£	£
1928	1,245	5,885,135	99,327,922	12,158,543
1938	1,085	8,404,688	154,602,159	25,313,077
1939	1,077	8,643,233	157,645,606	25,896,566
1945	1,050	9,404,877	238,494,150	44,824,190
1946	1,037	9,730,140	247,196,519	50,787,442
1947	1,032	9,976,709	248,187,669	55,719,113
1948	1,030	10,162,299	244,658,947	60,404,372

Capital Funds of Retail Societies

The main source of capital of retail societies is share capital. This is subscribed almost entirely by the individual members, who, under the Industrial and Provident Societies' Acts, may hold not more than £200 each. (The rules of a society may state a lower maximum than this, but that is now unusual.) In 1948 total share capital amounted to approximately £245 millions. The figure has grown consistently over a long period of years from two main sources, namely, actual contributions of share capital by members which constitute part of their domestic savings, and from dividend on purchases and interest left to accumulate in share capital accounts. In normal years it was estimated that half the increase in share capital in any one year came from amounts from the latter kind left to accumulate. In the middle and latter war years share capital increased rapidly, illustrating the difference between the saving and spending capacity of consumers, who in that period had more money than coupons; but in 1947 and 1948 a reverse trend was noticed and share capital in total tended to diminish slightly. One important feature of share capital which it is necessary to point out is that in the case of retail societies it is almost entirely withdrawable share capital. In fact, only about £1 million of the total is in transferable shares.

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The shares of a co-operative society are not bought and sold on the Stock Exchange like the shares of a Joint-Stock Company. Likewise, there is no question in the case of a co-operative society of authorized or nominal capital on the one hand and paid-up, or called-up capital, on the other hand. Any person over sixteen may in law become a member of a co-operative society by the payment of a very small deposit, but the first pound share must be paid up quickly either by direct contribution or by an accumulation of dividend. The share capital account of a member, because of the easy withdrawability, is often used in the manner of an unofficial savings bank, and in many working-class homes the holding in the co-operative society constitutes the backbone of the family saving, particularly in normal times.

A large secondary source of capital funds is in the shape of loans. A society may take power in its Rules to accept loans from members on the conditions set out in its Rules. At the end of 1948 just over £60 millions was represented by loans.

A third and much smaller source of capital is in savings bank deposits. By law a society with withdrawable share capital is not allowed to engage in the business of banking. Within this limit, however, societies may organize "Penny Banks" with a limited holding of £20 per depositor, and a limited deposit which must not exceed ten shillings. The total amount of savings bank deposits at the end of 1948 was approximately £6½ millions. These small savings banks are not now as important as they were, either from the point of view of the individual or the society. In the early days they were instrumental in encouraging thrift, and they were a very useful source of capital accumulation. The position in later years is somewhat different in this respect.

In addition to the above-named capital funds, which constitute a direct and individual liability to the member on the part of the society, there are the Reserve and Insurance Funds of the retail societies which constitute collectively-owned capital. At the end of 1948 these funds amounted to £22 millions. They rank in the Balance Sheets of co-operative societies in exactly the same way as Reserve Funds rank in the Balance Sheet of a Joint-Stock Company.

Other Liabilities of Retail Societies

The heading for sundry funds, in the "National Balance Sheet" (see Appendix), includes Bank Overdrafts, Stamps, Clubs, Tokens, Mortgages on Property, and Staff Guarantee Deposits, etc. Share interest is that not yet credited to share capital account, and "Balance Disposable" represents the amount of surplus still not allocated at the end of the last trading period, which for the most part is either a quarter or a half year. It is immediately allocated or paid out to members in the next few weeks following the end of the trading period, but, as will be understood, there is always a balance of this nature to be carried forward.

Employment of Capital by Retail Societies

The manner in which retail co-operative societies employ their capital differs greatly from the manner in which other types of business employ their capital, and there are two main reasons for this difference. One is the fact already mentioned that retail societies with withdrawable share capital perform a function very similar to an unofficial bank for members' savings, and the other is the fact that the retail societies constitute the financial basis of the Co-operative Movement, and they finance the wholesale societies and local federal societies and also contribute capital to a number of co-partnership co-operative societies. Thus, in the "National Balance Sheet" of all retail societies it will be seen that there is a large figure representing investment of capital not used in the business of retail societies, which was, in fact, in 1948 almost 68 per cent. of total assets.

Apart from this special feature the other assets of retail societies, which may be termed "trading" assets, follow the usual plan with such main items as (*a*) stocks, (*b*) property fixtures and fittings, (*c*) debts, and (*d*) cash in hand or at bank.

A special note perhaps ought to be made about the figure for property fixtures and fittings. There is no doubt that in the case of most co-operative societies this figure in 1948 represents a heavily written down figure as compared with the original cost, because co-operative societies pursue a regular and consistent policy of depreciation. Likewise, as property values have risen, particularly since pre-war years, the aggregate item for property in the "National Balance Sheet" must be standing now at a very low figure in relation to its current value. A point which should

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be noted, however, in connection with this position is that, generally speaking, there may not be a ready market for co-operative property. Most societies own their own property, and only a small proportion is rented. The total figure for property includes the value of certain property which is not used directly in trade, such as halls, etc. It also includes a relatively small amount representing house property owned by retail societies. A figure for the amount of "non-trade" property is published in the Annual Statistics.

At the end of 1948 over 70 per cent. of the investments of retail societies was with the wholesale and other co-operative societies and 14 per cent. was in Government Funds. The remainder was in Building Societies, Municipal Funds, and advances to members on house property.

The accumulation of capital funds, and particularly the large increases in capital registered in the war years, are reflected in the Table shown hereunder, in which it will be seen that the value of investments outside a retail society's business has increased to a much higher figure by the end of 1948 than the figures for the pre-war years.

TABLE 2

	Stock in Trade £	*Property* £	*Investments* £
1928 . . .	19,488,498	40,537,013	68,104,916
1938 . . .	19,910,223	56,501,373	137,651,364
1939 . . .	22,594,173	57,727,611	142,332,046
1945 . . .	23,333,320	52,327,704	262,787,095
1946 . . .	26,638,698	54,964,136	280,789,309
1947 . . .	38,390,727	59,182,949	278,815,865
1948 . . .	45,067,444	63,507,610	270,262,382

Retail Societies' Balance Sheets

Societies do not publish identical Balance Sheets, although efforts are constantly being made by the Co-operative Union to secure a higher degree of uniformity in co-operative accounts. The Co-operative Union issues an Annual Return for completion by all societies, and it is by that means that the statistics are obtained for the Annual Reports. The Annual Statistics of co-operative societies do not conform to the calendar year. The Industrial and Provident Societies' Acts allow co-operative societies to conclude their financial year any time between September and January inclusive.

Retail Trade

The total retail trade of co-operative societies has increased consistently throughout the present century, with the exception of the slump years 1921/1923 and 1931/1933. A Table showing the annual figures of retail trade is available in the Co-operative Union Reports (covering the years 1881, 1891, 1901 and 1911 to 1948). It will be appreciated, of course, that the changes in the cash value of co-operative retail trade cannot be separated from the changes in retail prices, and in the last ten years in particular increases in prices have tended to dominate cash sales figures.

Table 3 shows the retail trade for the years 1928, 1938 and 1948, with an indication of the broad departmentalization of the figures.

In the published statistics, beginning with the year 1946, two columns are shown for the sales of retail societies described as "direct" and "indirect." The "direct" sales compare with previous years because they are the sales made through the departments of the societies. The "indirect" sales represent the purchases of a society's members made through one or other of the local federal societies. If this latter trade were not brought in by this means it would be missed out of the figure of aggregate retail trade, because the trade of the local federal societies is not added in with the trade of the retail societies in the final summaries. For the purpose of calculating

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TABLE 3

	1928 (£ *mills.*)	1938 (£ *mills.*)	1948 (£ *mills.*)
Grocery, Bread and Confectionery	125·1	152·2	261·2
Butchery	17·4	22·0	33·3
Greengrocery, Fruit and Fish	2·6	4·4	12·2
Dairy	7·7	23·0	56·8
Total Foodstuffs	152·8	201·6	363·5
Drapery	16·5	19·6	43·1
Tailoring and Outfitting	5·1	6·8	12·8
Boot and Shoe	5·9	6·4	15·0
Furnishing and Hardware	4·3	8·6	24·9
Total Dry Goods	31·8	41·4	95·8
Coal	6·9	12·5	21·2
Chemist	0·6	2·1	9·0
Other Departments	17·3	5·7	13·1
Total Retail Trade	209·4	263·3	502·6

wages and expenses costs the "direct" trade only should be used as a base, but in calculating trade obtained from a society's membership the total of the "direct" and "indirect" trade should be the basis.

The figure of "indirect" trade was £3·3 millions in 1948. This represents the actual retail trade of the local federal societies referred to on p. 244.

Surplus of Retail Societies

Two figures are shown for the net surplus of retail societies in the aggregate. One figure includes share interest, and the other excludes share interest. The point here is concerned with the fact that as distinct from loan interest, which is a charge against surplus, share interest is actually a disposal of surplus. Share interest is, however, such a recognized feature of co-operative trading surpluses that it tends to be treated separately from the other allocations from surplus. In 1948 the total net surplus was £46·7 millions, of which £6·6 millions was share interest. The main item allocated from net surplus is, of course, dividend on purchases, but each year the amount allocated for dividend is less, by about £2 or £3 millions, than the total net surplus excluding share interest because of other allocations from surplus such as allocations to reserves, education grants, charitable donations, etc. A table is now published in the Annual Statistics made retrospective to 1943, which shows the average dividend rates for the whole Movement and the various geographical sections.

Employees and Wages of Retail Societies

Retail societies in 1948 had 261,000 employees broadly divided as between 218,000 distributive and transport employees and 43,000 productive and service employees. The corresponding amounts for wages and salaries were approximately £53 millions for distributive including transport, and £11½ millions for productive and service. The way in which these figures for employees of retail societies have been presented in the published statistics has changed over a period of years. Originally the transport employees were grouped with the productive and service employees,

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but from 1935 to 1939 inclusive, employees were analysed separately over the three main departmental groupings, viz. distributive, productive, transport. In 1940 and thenceforth the transport employees were grouped with the distributive employees, for in the activities of a retail society distribution accounts for about 90 per cent. of transport.

Shops of Retail Societies

Information about the number of shops operated by retail societies is not compiled and published annually in the main statistics. From time to time, however, a census of co-operative shops* is made, and the figures from the last census, made in 1946, show that there was an aggregate of just over 25,000 co-operative shops. It is difficult to define a shop, and in the co-operative census, premises of various size were counted in each case as one shop if they had a separate entrance for customers and were under separate shop management. There were 11,500 grocery and provisions shops included in the total, the next highest departmental figure being over 5,000 butchery shops.

Productions and Services of Retail Societies

In the published statistics a figure of £57 millions (at wholesale prices) in 1948 was shown as representing the productions and services of retail societies. This figure should be read with greater caution than any other figure in the published statistics. In the main the type of production undertaken by the retail societies would possibly be best described as a pre-distribution service, for the kind of productive and service work undertaken is ancillary to retailing. One of the largest items in the aggregate figure is represented by baking and confectionery. For the most part the productive activities of retail societies do not exactly line up with what is included under the general description of production in a national sense. Services include laundries, funeral furnishing, etc.

Local Federations of Retail Societies

This type of society, which has been referred to several times previously, is representative of a group of retail societies in a particular area, and it is formed in the main for such purposes as dairies, bakeries, laundries, coal, boot repairing, funeral furnishing, drugs, etc. These local federations pursue such productive and service activities in the same way as the large retail societies organize these departments on their own account, and thus their activities must be read with similar activities of the retail societies as a whole. In 1948 there were 82 such societies with a total trade of £12/13 millions. The share capital of these societies and the loans held by them are subscribed wholly by the constituent retail society members.

The sales of such societies to retail members (£3·3 millions) is that element previously described as the "indirect" sales of retail societies. The remainder of the trade of these Local Federations is, however, in the category of wholesale trade.

The Wholesale Societies

The two largest organizations in the Co-operative Movement are the two Wholesale Societies, namely the Co-operative Wholesale Society operating in England and Wales, and the Scottish Co-operative Wholesale Society operating in Scotland. These societies are owned by the retail societies and other co-operative societies which are the shareholders. There are no individual shareholders (except in the case of the S.C.W.S., which had a small shareholding held by 287 employee members in 1948). As indicated previously, the largest proportion of the investments of the retail societies is deposited with the two wholesale societies, and in 1948 the share capital of the C.W.S. was just over £20 millions, whilst they had loans to the amount of £144 millions The S.C.W.S. had share capital of £2·3 millions, and loans amounted to £17·7 millions.

The wholesale trade of the C.W.S. in 1948 amounted to £252·5 millions (at wholesale prices), whilst the figure for the S.C.W.S. was £55·3 millions. This trade is almost entirely with the retail societies and other co-operative organizations. The retail societies do not, however, obtain all their goods from the wholesale societies. The proportion is about 70 per cent. for the retail

* *Co-operative Retailing* (Co-operative Union).

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societies as a whole, but the proportion is higher for the food departments than for the non-food departments.

About one-third of the goods sold by the Wholesale Societies was made in their own factories. In 1948 the factory value of goods produced by the C.W.S. was just over £78 millions, and that of the S.C.W.S. was just over £20 millions. There is some reference to the significance nationally of the C.W.S. figures for production in various trades in the *Journal of the Royal Statistical Society.**

Both Wholesale Societies engage in the business of banking. The C.W.S. has had a Banking Department, which comprises a bank in a national sense, for a number of years. The Banking Department of the S.C.W.S. has only been in existence for a year or two. These Societies are allowed to engage in the business of banking because their shares are transferable.

In addition to holding a large number of accounts of friendly societies and trade unions, together with some municipal accounts, the banks of the Wholesale Societies provide an outlet for the capital of the two Societies, which is over and above the trading requirements of the Societies. Through these co-operative banks there is a large amount of surplus capital available which, in the main, is invested in Government and gilt-edged securities. The figures relating to the banks of the two Wholesale Societies will be found in the Co-operative Union Annual Statistics.

There are two other separate societies which emerge from a combination of the C.W.S. and the S.C.W.S. One is the English and Scottish Joint Co-operative Wholesale Society, which engages in the production of tea and cocoa and chocolate. This Society owns a number of plantations in Ceylon and India. The sales of the joint society in 1948 were £11/12 millions, but these sales are duplicated in the sales of the two separate Wholesale Societies. The two separate Wholesale Societies comprise the membership of the joint society and provide the whole of its capital funds. The other joint organization representing the two Wholesale Societies is the Co-operative Insurance Society. This Society transacts practically all the insurance business of co-operative societies. It undertakes fire, accident, burglary, fidelity, and general insurance, and in addition to the usual forms of life assurance, organizes a system of Collective Life Assurance, by means of which a society can insure the whole of its members by taking out a single policy. The business of the Society is not confined to co-operative societies or co-operative members. The main statistics relating to this Society are published in the Annual Co-operative Statistics.

The C.W.S. also has a subsidiary organization described as the National Co-operative Chemists. This is a national federation for the pharmacy trade which engages in retailing. This Society may operate in the area of a retail society by arrangement with the retail society, and because of the fact that the retail society wishes to have credit for such trade transacted with its own members, the trade of the National Co-operative Chemists' Society is included with the trade of the retail society as "indirect" trade (in the same way as the retail trade of local federations previously described). To avoid duplication the figures of the National Co-operative Chemists' Society are not included in total with the trade of the retail societies.

Co-operative Productive Societies

In addition to the productive activities of the retail co-operative societies and the wholesale co-operative societies, there is an additional figure for co-operative production coming from a separate group of co-operative productive societies, including the co-operative co-partnership societies. The co-operative co-partnership societies are not part of the consumers' Co-operative Movement as are all the societies commented on hitherto. They are, as their name implies, mainly controlled by their own employees who invest capital in them, although in recent years an increasing amount of the capital of these societies has come from the consumers' societies, and the retail societies provide almost the entire market for the goods produced by the co-partnership societies.

In the group of productive societies, which were 46 in number in 1948, there are, however, a few societies which are not co-partnership societies, such as the Co-operative Printing Society. These few societies are linked in the main with the consumers' societies, as also is the Co-operative

* Vol. CVIII, 1945: "The Structure of British Industry," by Leak and Maizels.

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Press Society, which is a separate national society financed by various other co-operative organizations, and which owns and produces the weekly co-operative papers and other co-operative journals.

Agricultural and Fishing Co-operative Statistics

As indicated in the first paragraph, the statistics relating to agricultural co-operative societies are not included in the Co-operative Union statistics. The National Farmers' Union is the registering body for agricultural societies in England and Wales. Reference to statistics of agricultural societies will also be found in the various reports and year books noted in the bibliography attached hereto. The most reliable reports relating to agricultural (and fishing) societies, however, are those published by the Registry of Friendly Societies, and the statistics for Great Britain taken from this source are shown in the Appendix.

International Co-operative Statistics

There is a Co-operative Movement in most countries of the world. These national Co-operative Movements include consumers, producers, agricultural, credit societies, etc. Information about the statistics of Co-operative Movements in other countries can be obtained from the International Co-operative Alliance, 14, Great Smith Street, Westminster, London, S.W.1.

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APPENDIX

CO-OPERATIVE STATISTICS, 1948

Detailed Summary Showing Societies of Various Types

Type of Society	*Number of Societies*	*Number of Members*	*Liabilities*							*Assets*		
			Share Capital	*Loan Capital*	*Savings Bank Deposits*	*Sundry Funds (including Overdrafts ranking as Capital)*	*Reserves and Insurance Funds*	*Sundry Liabilities*	*Disposable Balance*	*Total Liabilities and Assets*	*Stock-in-Trade*	*Property and Fixed Stock*	
			£	£	£	£	£	£	£	£	£	£	
Retail Distributive Societies	1,030	10,162,299	244,658,947	60,404,372	6,489,112	24,159,893	21,937,927	21,884,783	18,954,243	*d*398,489,277	45,067,444	57,076,081	1
Local Federations	82	1,981	2,841,940	4,308,885	..	347,059	726,669	536,341	399,446	*d*9,160,340	418,304	3,440,070	2
Productive Societies	46	15,331	672,748	517,972	4,396	148,324	1,123,681	379,162	353,995	*d*3,200,278	982,153	457,923	3
Co-operative Wholesale Society	1	1,042	20,143,736	143,991,675	..	96,206,821	19,010,046	13,323,060	4,061,430	296,736,768	17,867,110	10,169,221	4
Scottish Wholesale Society	1	*212	2,312,452	17,685,804	..	238,056	3,528,863	2,090,476	494,100	26,349,751	4,584,413	3,432,295	5
English and Scottish Joint Co-operative Wholesale Society	1	2	2,408,000	..	..	..	812,011	3,851	219,473	3,443,335	493,484	1,082,100	6
Co-operative Insurance Society	1	2	52,500	..	..	56,877	86,154,196	2,173,610	102,095	88,539,278	..	131,296	7
National Co-operative Chemists	1	106	60,063	103,574	..	26	71	31,018	845	195,596	101,302	34,140	8
Co-operative Press	1	845	268,411	212,513	..	33,814	117,643	16,482	4,944	653,807	26,595	154,071	9

* Plus 287 employee members.

d Includes deficit or suspense, the total of which amounts to £12,670.

Detailed Summary Showing Societies of Various Types (continued)

	Assets					*Operations for the Current Year*									
						Number of Employees		*Salaries and Wages*		*Sales*					
	Non-Trade Property	*Investments*	*Debtors for Goods*	*Cash in Hand and at Bank*	*Sundry Assets*	*Distributive*	*Productive and Service*	*Distributive*	*Productive and Service*	*Direct*	*Indirect*	*Own Productions and Services (Wholesale Prices)*	*Interest on Share Capital*	*Net Surplus (Excluding Share Interest)*	*Grants for Education*
	£	£	£	£	£			£	£	£	£	£	£	£	£
1	6,431,529	270,262,382	10,104,738	6,975,708	2,571,202	217,798	43,064	52,845,344	11,587,706	499,289,939	3,326,593	57,045,737	6,633,472	‡40,088,032	371,797
2	129,221	4,250,625	345,979	457,888	110,747	1,678	13,106	438,708	2,744,571	12,680,258	..	10,271,284	87,393	‖1,113,132	..
3	11,988	874,779	595,433	256,672	16,359	..	6,640	..	1,646,038	5,497,121	..	5,497,121	31,537	§476,624	6,735
4	721,920	228,856,209	15,201,295	22,726,009	1,195,004	8,933	41,044	2,514,990	10,442,150	252,469,693	..	80,111,377	749,765	7,412,214	8,263
5	..	*13,264,047	4,286,604	782,160	232	2,479	13,673	561,771	3,311,448	55,330,870	..	20,296,893	80,213	1,091,852	467
6	11,900	11,777	310,827	1,533,247	..	1,149	†252	272,397	†55,265	11,668,451	..	1,886,066	100,333	444,779	..
7	705,946	85,050,275	1,017,753	788,649	845,359	..	10,530	..	1,164,657	*21,708,741	..	..	2,625	958,390	..
8	..	31,823	4,863	7,590	15,877	127	..	31,926	..	233,376	..	..	771	844	..
9	25,558	221,596	44,527	59,576	121,884	..	333	..	174,797	454,821	..	454,821	8,036	44,302	..

* Premiums.
† Exclusive of Overseas Estates.
‡ Total Surplus of Societies showing a surplus; some Societies showed a deficiency, the total being £6,032.
‖ Before deducting the deficiency of £2,304.
§ Before deducting the deficiency of £6,774.

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Statement of Liabilities and Assets of the Retail Distributive Societies of Great Britain and Ireland, 1948

Liabilities	*Amount*	*Per cent. of Total*	*Assets*	*Amount*	*Per cent. of Total*
	£			£	
Shares	244,658,947	61·40	Stocks	45,067,444	11·31
Loans	60,404,372	15·16	Property	63,507,610	15·94
Savings Bank Deposits	6,489,112	1·63	Investments	270,262,382	67·82
Sundry Funds	24,159,893	6·06	Debtors	10,104,738	2·54
Reserve and Insurance Funds	21,937,927	5·51	Cash in Hand and at Bank	6,975,708	1·75
Sundry Liabilities (including Creditors)	21,884,783	5·49	Sundry Assets	2,571,395	0·64
Share Interest and Balance Disposable	18,954,243	4·75			
	£398,489,277	100·00		£398,489,277	100·00

(From the Report of the Registry of Friendly Societies for Great Britain)

Agricultural and Fishing Societies

The undermentioned trading societies, all of which are registered under the Industrial and Provident Societies Acts, are divided into four groups: (i) Requirements Societies, whose principal function is to supply their members with seeds, manures, utensils or other requirements for the carrying on of agriculture; (ii) Produce Societies, which are chiefly concerned with the marketing of members' agricultural produce; (iii) Farming and Growing Societies, which themselves undertake growing operations; and (iv) Fishermen's Societies, which supply fishing gear to, and market fish on behalf of, their members.

	1948			
	Number of Societies	*Number of Members*	*Sales*	*Surplus on Year*
			£	£
Requirements Societies	212	133,333	26,571,000	1,040,000
Produce Societies	167	64,903	23,686,000	422,000
Farming and Growing Societies	34	1,584	281,000	24,000
Fishermen's Societies	54	1,822	317,000	7,000
All Trading Societies	467	201,642	50,855,000	1,493,000

At the end of 1948 there were also 707 service societies, which supplied their members with some service connected with agriculture, such as the provision of small holdings and allotments, credit, threshing facilities and cattle insurance. Some were registered under the Industrial and Provident Societies Acts, and others under the Friendly Societies Acts. The total membership was 198,000, compared with 194,000 members of 710 societies at the end of 1947. The most important of the service societies are the small holdings and allotment societies. At the end of 1948 tenants of these societies numbered 81,000.

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REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

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1.—*The Theory of Inbreeding*. By R. A. Fisher. Edinburgh and London: Oliver & Boyd, 1949. viii + 120 pp. $9\frac{3}{4}''$. 10*s*. 6*d*.

A new book by Fisher is something of an event, though this new monograph is, perhaps, too specialized to have so wide an appeal as his earlier publications, and in particular will be of most interest to mathematical geneticists. The theoretical arguments make difficult reading (at least to the reviewer, who cannot claim to have followed all of them). It would, however, be a pity if other readers were put off altogether, for the mathematical portions are sandwiched between an introductory chapter and a final appendix on the function of inbreeding in animal and plant improvement, both of which can be more easily read.

In the second chapter on Segregating Inbred Lines, in which attention is paid to the number of individuals necessary to ensure enough eligible matings in an inbred line, the transition to algebraic formulae seemed extremely abrupt. The third chapter on Progress towards Homozygosity begins on a more familiar pattern, the trend to homozygosis due to the inbreeding being discussed in detail for a single gene locus and repeated sib- (brother-sister) matings. The number of allelomorphs is left arbitrary, and the treatment is thus more general than if only a pair *A*, *a*, say, is considered. Mathematically the apparatus is the well-known repeated pre-multiplication of a vector by a matrix, the vector representing here the frequencies of different mating types in any generation, and the matrix the set of new vectors arising in the next generation, one vector from *each* mating type. Theoretically, the rapidity of the approach to homozygosis depends on the value of the largest latent root of the matrix. It may be wondered whether some readers would not have welcomed a reference to some relevant mathematical work on matrix algebra, as presumably they should be quite capable of following this as well, and might find it a useful supplement to Fisher's own discussion, especially those who have any difficulty with the latter. To any who attempt such supplementary reading it should be noted that Fisher sometimes employs non-standard terms, such as a *principal component* of frequency for a linear function of the mating type frequencies which drops by a constant fraction (equal to one of the latent roots) after each generation. The coefficients of this linear function constitute the row latent vector in more standard terminology, and, especially for the dominant latent root, are also referred to by Fisher as the *complexities*, the corresponding column latent vector determining the ultimate frequency distribution of matings still heterozygous. A warning seems necessary that these vectors are not always so simple to handle algebraically as in this first example, as Fisher himself notes later (p. 91).

One rather remarkable result pointed out in this chapter is that, while parent-offspring inbreeding is equally efficient with sib-inbreeding, a mating of either type interpolated in a series of the other type retards progress, and to the same extent. The final section of the chapter, dealing with the lengths of tracts of heterogeneous origin, might well have formed a distinct chapter, as it is important, and moreover, involves another somewhat abrupt step in both the genetical problem and the mathematical technique of handling it.

In Chapter IV other systems of inbreeding are discussed, including the parent-offspring system, and systems for polysomic organisms. In this latter case there is a complication owing to the existence of more than two chromosomes capable of pairing and interchanging segments; and the frequencies of the different possible types of gamete arising from a tetrasomic or hexasomic organism are expressed in terms of a parameter which depends on the chromosomal position of the gene. The two technical Appendices A and B deal respectively with the modifications in the appraisal of breeding system efficiencies necessary for species in which single offspring at a birth must be expected, and self-sterility mechanisms in hermaphrodite plants.

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While the reviewer cannot claim to speak authoritatively on the genetical aspects of this work it seems clear that it represents a valuable though rather individual account of Fisher's recent researches in this field. It does not include a complete survey of the literature; for example, the few references in the mathematical sections are all to papers with which Fisher has been associated, and some other well-known contributors to work in this field, such as J. B. S. Haldane, are not mentioned. An index would have been useful. M. S. B.

2.—*Probability and the Weighing of Evidence.* By I. J. Good. London: Griffin, 1950. viii + 119 pp. $8\frac{3}{4}''$. 16*s*.

This book is the latest and one of the ablest of the long series of attempts to construct a theory of probability based on "degrees of belief." It is, therefore, not primarily concerned with the technical aspects of the theory of statistical inference. The theory put forward is somewhat similar to Jeffreys's but has a number of twists of its own. Dr. Good attempts to build a system of axioms for the probabilities of propositions, and regards his whole theory as consisting of these together with a set of "rules" and "suggestions." Being a theory of the probability of propositions rather than of events it is essentially dependent on the individual who uses the theory. This has the intriguing result that the word "you" is used throughout in a technical sense.

The difficulties of this method of approach are well-known and before we can be convinced of its superiority we naturally ask what can be urged against the orthodox method of inference, rejecting inverse probability, employed by most practising statisticians. Good's objections to the latter appear to be twofold. Firstly, he regards the ordinary theory defective in that it is unable to give a meaning to the expression "the probability of a hypothesis." Many, however, would regard this as empirically meaningless and not of great value in practice. Secondly, he criticizes the ordinary theory for requiring the use of judgment after (say) the significance level in a given problem is calculated. But it seems that judgment must be used in applying any theory of probability and that it is better to use a theory in which the resulting numerical magnitudes do not depend on some entirely subjective prior probability.

After describing the foundations of his theory the author considers its application to the weighing of evidence and statistical inference. The discussion is based on wide reading and is always stimulating, although there appear to be occasional obscurities in statement. For example, it is difficult to find a meaning for the statement on p. 36 that the purpose of the design of experiments is to ensure "that the intervals in which the probabilities are judged to lie are narrow rather than wide." Again on p. 76 statistics is divided into a descriptive part and a "predictive" part and in using the latter the statistician is said to "forecast" the properties of a population.

Theorem 21A on p. 52 is not a generalization of theorem 21, as stated, and in the latter it should be made clear that E(X) must exist absolutely. It is also a pity that in discussing various methods of fitting curves no mention is made of their efficiency or of the mistake of applying χ^2 as a goodness of fit test when the method of estimation is inefficient.

Some other topics might well have been included, for example, Smirnov's theorem on the convergence of an empirical distribution to a theoretical one, and Fréchet's discussion of the "method of arbitrary functions," which is an example of ergodic theory and throws some light on why empirical events appear to obey the laws of probability.

Statisticians fascinated by theories of probability will find this book pleasant and instructive to read and they are advised to read it, but it is doubtful if they will be convinced that the theory is preferable to the more usual approach. P. A. M.

3.—*Statistics.* An Intermediate Text-book. Vol. I. By N. L. Johnson and H. Tetley. Cambridge University Press, 1949. xii + 294 pp. $8\frac{1}{4}''$. 20*s*.

The history of insurance is inseparable from that of statistics, and many distinguished actuaries have contributed to the progress of statistical theory. Some critics may think that more use could be made of recent developments of mathematical statistics in the investigation of mortality, morbidity and disability than is actually the case, and they will welcome the news that the subject has been given a more central position in the new examination syllabus of the two great actuarial associations of this country. The book under review was primarily written for the use of students for those examinations and its sub-title indicates the level of treatment. Only Vol. I has so far appeared. This contains 10 chapters dealing with descriptive statistics and with a survey of probability theory. Moreover, the way is prepared to the solution of "the question of what technical properties of a test are desirable and of how to construct tests having properties which we have decided to be desirable" (pp. 264/5). This is promised for Vol. II.

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It is for the actuarial bodies to decide what they wish to include in their syllabus, and in this event the selection appears fair enough. It is reasonable to start off with statistics which young actuaries know from their daily work and to show how a maximum of information can be extracted from them. This is well done, even if some readers will find the replacement of the colour of balls in a box by the sex of randomly selected babies of spurious realism. (Incidentally it begs the question whether the sex ratio is, in fact, a probability.) The authors have set out to write a text-book, not a manual, and they are pleasantly unselfconscious about it. Their frequency theory of probability is not over-critical, but it is sufficient for their purpose. Occasionally, perhaps, better ways to the student's understanding could have been found. Is it not confusing to find the regression line of y on x derived in two steps, using least squares only in the second instance, whilst for the regression of x on y both constants are derived by the latter and more natural method (pp. 93/4)? The statement on p. 108, that the correlation coefficient is only zero when "the average value of y for *every* value of x is $\bar{y}$" is incorrect. On p. 96 the authors point out that the correlation coefficient reflects a change of the scales used for the variables "while the correlation is, of course, the same as before." Surely that depends on the precise definition of correlation and there is no matter of course about it. This and other similar slips appear to have been transferred from an earlier and less satisfactory book written by one of the authors; it is hoped that such traces of the earlier book will be removed from later editions.

The arrangement of the book is sometimes puzzling. The reviewer does not understand why the authors wish section 18 of Chapter 6 to be read not where it stands, but only when "the next chapter has been mastered." Chapter 9, on "Statistical Hypotheses," includes a section on "Estimation," which deals only with confidence limits. Chapter 10, "Simple Statistical Tests," has a first section on time series which looks rather out of place and is apt to lead the student who reads on to think that these must have something to do with tests of quality control. Incidentally, all these tests are based on a normal sampling distribution, with a note on their merely approximate validity.

Finally, a few words may be allowed concerning the exercises at the end of the chapters. They are on the whole well chosen, including also material from actuarial examination papers; some questions, however, seem to have been thrown in, rather carelessly, for full measure. Exercise 9.6, for instance, asks for a comparison between confidence limits and limits based on posterior probability. Surely this is far beyond the knowledge of readers who have not looked into a wide range of statistical books. Again, exercise 9.11 quotes a formula for the confidence limits of the "population expected value," and goes on to ask: "would you expect this formula to be reasonably useful for non-normal populations?" Only mature statisticians should tackle such a question, unless the word "reasonably" makes it a leading question and hence prejudices its value as an exercise (and as an examination question as well, for that matter).

In judging the book it must be remembered that it forms part of a series of text-books and had to be fitted into a larger frame. The second volume will show how determined the authors are to follow the road of modern statistics as opposed to makeshifts so popular in some fields of applied science. The present volume augurs well and can unreservedly be recommended to many more readers than actuarial apprentices. A great amount of solid work has gone into its writing and even experienced readers will find pleasure in glancing through the more discursive paragraphs, which contain a good deal of sound, convincing common sense. S. V.

4.—*Forecasts of the Population of the United States*, 1945–75. By P. K. Whelpton, assisted by Hope Tisdale Eldridge and Jacob S. Siegel. U.S. Government Printing Office, Washington, 1947. vi + 113 pp. $11\frac{3}{4}''$. 45 cents.

This little volume contains more information than its title suggests. Its main purpose is to present a number of calculations relating to the probable future population of the United States. The actual methods used in the forecasts are fairly conventional. Mortality and age-specific fertility rates are projected into the future on various assumptions and the resulting populations are obtained. In the case of mortality three different sets of age-specific death rates are assumed to have been achieved by the year 2000 and the rates for the intervening years are obtained by interpolation. In the case of fertility, likewise, three assumptions are made relating to gross reproduction rates in the year 2000 and these assumptions are then translated into age and parity-specific fertility rates in such a way that higher order births (parities of four and over) show a very large decline.

The assumptions about fertility and mortality are then combined with various assumptions relating to immigration to yield six different forecasts of the U.S. population by age, colour and sex, and these forecasts are discussed in detail. The two extreme assumptions of high mortality, low fertility and no immigration, and of low mortality, high fertility and 1,000,000 net immigration

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every five years yield totals of 151 and 185 millions by 1975 respectively. The medium assumptions which are rather more likely, would make the population total come to between 165 and 170 millions by that date.

The recent projections for this country published by the Royal Commission on Population were constructed by a slightly different method: in general, nuptiality was taken as the independent factor and the births resulting were calculated from fertility rates which were specific by duration of marriage rather than by age. In the U.S. forecasts nuptiality does not seem to have been taken as an independent factor. The reviewer regards the practice of the Royal Commission as preferable, though the differences between the two methods would probably not be large for a period of 30 years.

The forecasts themselves do not, however, exhaust the contents of the volume. Professor Whelpton devotes a chapter to an interesting and concise account of the fertility and mortality history of the United States to show why he regards the assumptions that he has made as reasonable. In another chapter some of the consequences of the expected movement of population are commented upon.

The construction of population forecasts seems to have become a part of the regular work of the Bureau of the Census. It is to be hoped that the Registrars General will undertake similar investigations for the United Kingdom.

E. G.

5.—*Stillbirths: Their Epidemiology and Social Significance.* By Ian Sutherland, M.A. (Cantab.), D.Phil.(Oxon.). Oxford University Press, 1949. xii+93 pp. $8\frac{1}{2}''$. 7*s.* 6*d.*

Dr. Sutherland has written an interesting, clear and concise account of stillbirths. He rightly points out that they have received too little attention in the past and puts forward many new and important details of their causation.

After discussing differences in definition and notification in other countries he limits himself to Denmark, Holland and New Zealand as having comparable data with Great Britain. In this country London experiences the lowest and Wales the highest rates. Since 1933 the rate has fallen in all areas and with increasing rapidity during the war years up to 1944, when the decrease suddenly halted. The improvement was greatest in those areas with the highest rates, although the pre-war positions were maintained relative to one another.

Medical knowledge on stillbirths is inadequate but there is known to be a close association between them and prematurity, and a high proportion of babies are dead before the onset of labour. This shows the importance of ante-natal factors, although general disease in the mother accounts for only perhaps 3 per cent. of stillbirths. Dr. Sutherland dismisses these diseases somewhat briefly, although four are mentioned: syphilis, diabetes, maternal rubella and haemolytic disease of the newborn. Chronic nephritis is not mentioned. The importance of all these diseases (except syphilis) is in the increasing likelihood of stillbirth with successive pregnancies, and because good ante-natal care can prevent some, at least, of the deaths.

There are a number of biological associations which Dr. Sutherland carefully analyses, e.g. the fact that stillbirths are more often males than females, that there is an increase of the rate after a maternal age of 25 years, and that the lowest rates are in second births with a gradual rise thereafter. The interval between births is important, the best interval being about three years, and the risk is increased where the gap is greater or less than this. Multiple births, and illegitimate births in young mothers, carry a higher risk and mothers who have produced one stillborn child are more likely to produce others than mothers who have not. Finally, there is a definite gradient of rates with social class, but the more favourable age and parity of the lower social orders tend to balance this.

The method of multiple regression was used to relate geographical variations in the environment to variations in the rates. The indices of the environment were taken as the percentage of low-paid workers, the percentage of men unemployed and the number of persons per room; the infant mortality rate at 3–12 months was included as a general index of adversity. To allow for age and parity two additional indices were chosen, and multiple regression equations based upon the six indices were calculated for the stillbirth and neonatal mortality rates separately. It was found that the stillbirth rate was associated with unemployment and poorly paid work but not with overcrowding. There were similar findings for neonatal mortality, but overcrowding was apparently of more importance, and both rates were associated with the general index of poor environmental conditions.

Dr. Sutherland considers nutrition in pregnancy may have been an important factor in the wartime decline in stillbirths and summarizes the major work in this field. There was no real evidence that maternal employment was harmful and the amount of antenatal care was not cor-

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related with the rates. On the other hand the percentage of births in institutions gave a definite negative correlation with the stillbirth rates. One somewhat doubtful assumption which Dr. Sutherland makes is in the explanation of the decline in the stillbirth rates during the war in the upper social classes. He suggests that it was "probably due partly to the ability of these sections of the community to make the best nutritional use of the restricted food supplies available." There seems little reason for these admirable qualities to come to an abrupt halt in 1944.

On only one other score might the reader disagree and that is in the reference throughout to "potential lives lost" by stillbirths. Morally, of course, this is true, as it is of contraception, but it is doubtful if the birth-rate would increase by any part comparable with the number of lives saved. Essentially stillbirths are wasted pregnancies with all the distress which that entails, but this small point detracts nothing from this work as a very valuable study of a much neglected problem.

J. P. W. H.

6.—*Taxable and Business Income.* By D. Throop Smith and J. Keith Butters. National Bureau of Economic Research Inc., New York, 1949. xxv+342 pp. 9″. $4.

This is the second book published on the initiative of the National Bureau's Conference on Research in Fiscal Policy. Mr. G. O. May, a well-known American accountant, has contributed an historical foreword on the differences between tax and financial accounting. It is an objective study which perforce travels over some old ground. The two concepts of income are compared, there is a descriptive account of the differences underlying them, and the quantitative significance of such divergencies is carefully examined.

Quite early in the book we meet the circumstance that information taken from Federal income tax returns is used extensively for the purpose of estimating national income. It also seems that national income statistics place some reliance upon the records kept by business firms for their own purposes. Thus, it is urged that information relating to both sets of data is essential for a proper understanding of the implications. It is the declared hope of the authors that their findings will serve a purpose by partly filling those gaps in our knowledge which relate to national income statistics. In this context it is pertinent to wonder whether the concept of either taxable or business income as currently developed is sufficiently appropriate for appreciation in the field of national income studies, but possibly this book may serve to put us in the way of a right view.

The present reviewer finds himself largely in conformity with a comment of Mr. Peloubet which appears as a footnote in the introduction. He says, "I particularly do not like the statement . . . 'It would be altogether incorrect to conclude that of the two concepts (taxable income and business income) one is right and the other is wrong.' The efforts of the accounting profession have been devoted for many years to making proper determinations of income. Income determined under generally accepted accounting principles is objectively determined and is meant to be as nearly correct as possible. It would seem to me that it would be a better approach to make it clear that taxable income is artificial and is not determined from any objective point of view. It is rather arrived at for a specific purpose, and is frequently so much in conflict with accepted accounting principles that a figure for taxable income would be regarded as misleading if published to stockholders or the public." The only question which now presents itself is whether or not generally accepted accounting principles are so objectively determined as to make apparent the economic concept of income.

The differences between taxable and business income in America are considerable; thus we are reminded that "at one extreme is the tax requirement that prepaid rent received must be included as income in the year when received—even for a taxpayer on an accrual basis—though the rent is a single payment covering several years' use . . . at the other extreme is the disallowance for tax purposes of charges to establish precautionary and contingency reserves." One finds it difficult to understand why in the former case the tax requirement cannot be brought into line with accrual accounting. In the latter case it is clear that a reserve of such order is based upon the judgment of management, and while it may be of great use to investors the basis of determination is not usually one which assures any high degree of probability that it will be fully taken up to meet the specific contingency contemplated. A subjective measure of charge is thus open to some suspicion. As one might expect, a concept of income which has to be embodied in a taxing statute is limiting and precise. It necessarily relies upon objective happenings rather than upon subjective estimates.

There is considerable discussion on the thorny question of depreciation. Inventory accounting comes in for comment, as does also the treatment of bad debts. Most of the matter incorporated under these heads is familiar to accountants. What *is* interesting in the book is the summary of findings which opens Part II. Statutory net income figures compiled from unaudited tax returns

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are compared with book profit as reported to the Treasury and as reported to the Securities and Exchange Commission. The conclusion is reached that "on the average, for a large number of companies in most industries during the eight years 1929–36, book profit and statutory net income did not differ greatly . . . when book profit is compared with audited statutory net income the two figures tend to be about equal in most industries."

As one might expect, in mining and public utility industries book profit tended to exceed statutory net income by a fairly wide margin. Differing methods of providing for depletion and depreciation seem largely answerable for the divergence. It is also interesting to note that the margin between the book and tax figures seems to be larger for companies "reporting statutory deficits than for companies reporting statutory net incomes." Again it is concluded that variations between book profit and statutory net income do not appear to be related to the size of companies in any systematic manner. It is also implied that differences between book and tax income of all corporations and most major industry groups are not systematically related to business cycle phases, although it is said that when the differences are expressed as percentages of statutory net income cyclical patterns do appear. It is interesting to observe that the difference between book and tax income reported by a given company in any one year seem to be balanced by offsetting divergencies reported by the same company in other years. The present reviewer is left wondering whether similar conclusions obtain in this country.

The book contains an interesting chapter on Techniques, which largely deals with ratios described as Analysis X and Analysis Y with a variant of the former designated as Analysis Z. The Analysis X ratio apparently "measures the percentage difference between book and tax figures, such as for depreciation charges and net income." It is noted that for depreciation charges, the Analysis X ratio expresses the difference between book and tax depreciation charges as a percentage of the arithmetic mean of the book and tax charges. . . . A positive ratio indicates that the book item is algebraically larger than the corresponding tax item; a negative ratio that the tax item is algebraically larger."

The Y ratio designed to supplement the X ratio indicates "the relative importance of different sources of divergence between the two income concepts." As is clearly brought out, reliance on the X ratio alone can lead to false inferences if small amounts are involved, e.g. a divergence in bad debt expenses might throw up a large X ratio but still cause only a small difference between the two income figures. The Z ratio apparently expresses the difference between book profit and statutory net income as a percentage of statutory net income. It is plain that this practice has been followed in order that the results may be compared more easily with national income estimates, largely based on tax data. It is probable that there is much to be gained by the application of these techniques to future enquiries, e.g. one would like to know the conclusions to be drawn from divergencies between commonly accepted accounting measures of money profit and economic measures of real profit. Nevertheless it seems that such an enquiry cannot be started until some means is found to achieve simple objective expressions of the latter measures.

F. S. B.

7.—*London Travel Survey*, 1949. Published by the London Transport Executive, London, 1950. 47 pp. 9″. 7*s*. 6*d*.

This is the report of a survey carried out by London Transport, with the help of Research Services Ltd., early in 1949. The declared purpose of the enquiry was "to establish the extent to which Londoners make use of public transport for the journey to and from work, and to discover also the other purposes for which they travel." In a sense, it has done more than that, for it provides useful data on the social background of the Londoner, in terms of the size and composition of the household and the status of its members.

The results are based on interviews with the members of 2,695 households, chosen to be a representative sample of households within a fifteen miles radius of Charing Cross. This area is referred to as "Greater London" and is subdivided, in the analysis, into the County of London (further split into the areas North and South of the Thames) and the remainder, here termed the Suburban area. In addition, the members of 305 representative households in Dartford, Reigate and St. Albans were interviewed, but it is not claimed that these districts are necessarily representative of the area served by County Buses and Coaches.

Many of the results presented in this first report—much material still remains to be analysed—are of considerable interest. Some are in accordance with general expectation, such as the popularity of the bus, as opposed to other means of public transport, with children. That this vehicle attracts women more strongly than men is not so obvious. Nor had one suspected, perhaps, that the higher the income group, the greater is the regular use made of the tubes and, to some extent, the buses—while, with trolleybuses and trams, the tendency is in the

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opposite direction. Putting such results into another form, as is done in Table 8, shows us "the types of passengers likely to be found travelling in a railway car, a bus, trolleybus or tram at any particular moment." It would be amusing, as one travels around London, to study how the composition of the passengers in the buses, etc. which one uses deviates from this norm.

The survey provides valuable information on the journey to work, showing the means of transport used, the time spent on it, the number of changes made (it appears that 56 per cent. of the workers in the sample are fortunate enough to be able to travel to work without a change) and the times of starting and finishing work. In addition, there are chapters on casual journeys and the cost of regular travel.

Although the Appendix, setting out the sampling techniques employed, is fairly detailed, it is not quite clear why the electoral registers, rather than the more accurate rating lists, were used for sampling. The method of selecting the interviewing areas so as "to ensure, broadly, an even spread of interviewing areas between each sector, and the suburban area as a whole and the two halves of the County" is also not explained. Substitutes—carefully defined—were permitted only after three calls, and it would be interesting to know the extent of substitution actually experienced and whether any bias is thought to have been introduced by it.

In conclusion, it should be said that the results have been very skilfully analysed and presented, and that the method of enquiry is fairly fully explained—although the Questionnaire and Journey Record Sheet should most certainly have been reproduced in the Appendix. The report fills a gap in our knowledge of London's social life and one hopes that—in spite of what is rather a high price for such a short book—it will be widely read.

C. A. M.

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STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices compiled by the Ministry of Labour and National Service moved fractionally month by month between December, 1949, and March, 1950, but the cumulative effects raised the index, which is quoted to the nearest whole number, by only 1 point. The food index rose by about 2½ points in the period, owing to increases in the prices of certain vegetables and fruit. The only other figure which showed a movement of more than 1 point was that for household durable goods, in which increases in the prices of carpets, some kinds of drapery and soft furnishings and cotton sheets and woollen blankets were only partly offset by reductions in linoleum and pottery. The detailed figures for December to April were as follows:

(*Prices at June 17th*, 1947 = 100)

Date	*Food*	*Rent and rates*	*Clothing*	*Fuel and light*	*House-hold durable goods*	*Miscel-laneous goods*	*Services*	*Drink and tobacco*	*Total*
Weights:	348	88	97	65	71	35	79	217	1,000
Dec. 13th, 1949	119·5	100·3	117·1	114·7	108·1	113·1	106·1	107·5	113
Jan. 17th, 1950	120·3	100·4	117·1	115·1	108·1	113·6	106·1	107·5	113
Feb. 14th, ,,	120·6	100·4	117·4	115·2	109·6	113·7	106·2	107·5	113
Mar. 14th, ,,	121·3	100·4	117·8	115·4	110·0	113·3	106·5	107·5	113
Apr. 18th, ,,	122·0	101·3	118·4	115·2	110·6	113·3	106·6	107·5	114

In publishing the figures the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e. to the nearest first place of decimals. The decimals are shown only in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attributed to the decimals, and for any other purposes, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates also rose fractionally and the whole number was raised from 109 in December to 110 in January. The following is a summary of the figures since June, 1947, when the present series was instituted.

(*Wage Rates at end of June*, 1947 = 100)

Date (end of month)	*Men*	*Women*	*Juveniles*	*All workers*
June, 1947	100	100	100	100
September, ,,	101	101	102	101
December, ,,	103	103	106	103
March, 1948	105	106	107	105
June, ,,	105	107	108	106
September, ,,	106	108	109	106
December, ,,	107	109	110	107
March, 1949	108	110	111	108
June, ,,	108	111	111	109
September, ,,	108	111	112	109
December, ,,	109	112	112	109
January, 1950	109	113	113	110
February, ,,	109	113	113	110
March, ,,	109	113	113	110
April, ,,	109	113	113	110

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The total working population and the numbers in civil employment shown by the new series of man-power figures, which became available early in 1949, are as follows:

Thousands

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Mid-1948	16,057	7,089	23,146	14,945	6,981	21,926
Nov., 1949	16,099	7,285	23,384	15,141	7,166	22,307
Dec., ,,	16,074	7,244	23,318	15,109	7,113	22,222
Jan., ,,	16,112	7,258	23,370	15,142	7,123	22,265
Feb., ,,	16,086	7,249	23,335	15,125	7,119	22,224
Mar. ,,	16,074	7,229	23,303	15,136	7,108	22,244

It will be seen that between November and March the total working population showed a decrease of 81,000, 25,000 males and 56,000 females. The number in civil employment was 63,000 lower in March than in November.

The level of unemployment rose by 516 between January and February, but fell by 25,499 in the following month and by 18,298 in April.

Number of Unemployed Persons on the Registers of the Employment Exchanges of the Ministry of Labour and National Service

Date	*Men and boys*	*Women and girls*	*Total*
Dec. 5th, 1949	238,753	91,583	330,336
Jan. 16th, 1950	262,771	109,495	372,266
Feb. 13th, ,,	266,114	106,668	372,782
Mar. 13th, ,,	246,955	100,328	347,283
Apr. 17th, ,,	234,963	94,022	328,985

The total for April, 1950, includes 44,401 married women. The totals do not include registered severely disabled persons who are unlikely to obtain work other than under special conditions.

The progress made in the expansion of home agriculture as a means of saving food imports and dollar expenditure is reviewed in the *Economic Survey for* 1950 (Cmd. 7915) in continuation of the similar report last year. The five-year programme launched in 1947 was designed to raise agricultural output to about 20 per cent. above 1946–47, or roughly 50 per cent. above pre-war. Substantial progress was made in the crop year 1948–49, conditions being exceptionally favourable, and output was 9 per cent. above 1946–47. In 1949–50 conditions were only moderately good, but preliminary estimates suggest a further increase sufficient to bring the level of agricultural output to about 10½ per cent. over 1946–47. Crop yields generally were high but the wheat crop was below that for 1948–49. Livestock increased steadily and the output of livestock products in many cases exceeded the programme.

Acreage of Crops in the U.K. (thousands)

	1936–7 *to* 1938–9	1948–9	1949–50 *(estimate)*	1950–51 *(forecast)*
Bread grains	1,872	2,340	2,028	2,350
Other grains	3,429	6,016	5,988	6,330
Potatoes	723	1,548	1,309	1,300
Sugar Beet	335	413	420	416
Linseed	2	86	58	50

Livestock Production (percentage of pre-war)

Milk	100	122	126	129
Eggs	100	100	111	118
Beef and Veal	100	87	87	102
Mutton and Lamb	100	67	72	75
Pigmeat	100	47	64	71

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An important element in the programme is the growing of more fodder at home to replace imported feeding stuffs, and the Survey remarks that though the progress so far made in the grass-land campaign is difficult to measure statistically a very large general improvement ultimately is anticipated. The elimination of the feeding stuffs subsidy is expected to increase the incentive to grow grass and coarse grains for livestock feeding. In the past home livestock production has been largely dependent on the supply of foreign cattle foods and the aim of the present scheme is to secure greater production of cattle food on the farm while maintaining or increasing the growth of other crops such as wheat, sugar beet, etc., which help to save dollar imports.

The annual *index number of agricultural prices* calculated by the Ministry of Agriculture continues to rise and the figure for the calendar year 1949 reached 230 (on a 1927–29 base of 100). This was 11 points higher than the figure for the previous year and shows an increase of about one-third as compared with 1945, while the comparable pre-war figure (1937–39) is 90·5.

The changes in the past five years are shown below for the three groups of commodities which make up the index number. Allowance is made for Government subsidies, including payments in respect of acreage under wheat and potatoes. The acreage payments were equivalent in the case of wheat to 2*s.* per cwt. in 1948 and 1*s.* 5*d.* in 1949; for potatoes they were respectively 31*s.* 5*d.* and 29*s.* per ton.

(*Base* 1927–29 = 100)

	1945	*1946*	*1947*	*1948*	*1949*
Cereals and farm crops	183	183	197	220	221·5
Livestock and livestock products	164	178	199·5	215	229
Fruit, vegetables and glass-house produce . .	193·5	201	288	232	246
General Index	173	183	213	219	230

In the case of the commodities in the cereal group the changes on the average were small; wheat, potatoes and hops showed some increase, which was counterbalanced by a decline in barley and sugar-beet. The movement in the livestock group was more appreciable, all the articles included showing a rise. Among important items, the index for wheat increased from 229 in 1948 to 235 in 1949; for potatoes from 201 to 209; and milk from 234 to 248. As examples of the extent to which agricultural prices have risen in the last few years, it may be mentioned that in 1949 wheat averaged 24*s.* 4*d.* per cwt. as against 19*s.* 8*d.* in 1945; potatoes 209*s.* 8*d.* per ton compared with 157*s.* 7*d.*; and milk 2*s.* 8*d.* per gallon against 2*s.* 1*d.*

(2) Other Statistics

A Report has been issued (October, 1949) by the Food and Agricultural Organization entitled *The State of Food and Agriculture*, 1949—*A Survey of World Conditions and Prospects.* This covers all ordinary agricultural and livestock products, sugar, fats and oils, citrus and dried fruit, fibres, fishery and forest products, fertilizers and farm machinery, and contains summary statistics in regard to all these products, as well as an interesting Report by the Director-General on various aspects of the international situation. An activity of the F.A.O. which has a connection with this is the development of internationally comparable index numbers of Agricultural production. These have been constructed for 52 countries covering 80 per cent. of the world's population, and consist of two main series, one for food production and the other for the production of other agricultural commodities, such, for example, as textiles, etc. It is pointed out that such index numbers are useful in summarizing a mass of information in a few simple figures. For example, the difference between the present and the pre-war pattern of food production is indicated by the fact that with a base 1934–38 = 100 the indices for 1948–49 were 139 for the United States, 63 for Poland and 77 for Czechoslovakia. Similar index numbers are being attempted for the imports and exports entering into international trade and for "available supplies" as distinct from aggregate production. The methods of calculation of the food index numbers are described in an appendix to the "State of Food and Agriculture, 1948."

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The Report of the Director-General on the work of the Food and Agriculture Organization of the United Nations, 1948–49, refers to experiments that are being made in training statisticians for service in countries where the collection of statistics, particularly agricultural statistics, is somewhat undeveloped. The object is to give instruction and guidance in problems connected with the 1950 World Census of Agriculture as well as in the collection of other statistics locally. The operation of an agricultural census, it is pointed out, is a large undertaking even for countries with considerable experience: for those without much previous experience the difficulties are very great. The first comprehensive training course was held in Mexico City from September 2nd to December 10th, 1948, jointly by the F.A.O. and the Mexican Central Bureau of Statistics, with the co-operation of the United Nations Statistical Office, the Inter-American Statistical Institute and the United States Bureau of the Census. Sixty persons from 16 countries of South and Central America took part, of whom two-thirds were Government officials. The curriculum included statistical methods, a refresher course in mathematics, and courses in agricultural census taking, population census taking and statistical sampling. Lectures dealt with current agricultural and labour statistics, census administration and the taking of housing censuses. The Government of Mexico conducted an experimental census of agriculture and population in the neighbourhood. A Report on the project has been issued by the United Nations. A somewhat similar course was held in Guatemala City in May–June, 1949, which was attended by representatives from Central American and Caribbean countries. A major feature was an experimental census in two areas and the participation of those attending in the editing, coding and tabulation of the schedules as well as in a critical review of the experience in field enumeration. Plans in hand contemplated similar courses in India, and these would be available for countries in the Far East. Generally the programme for 1950 included schemes for the expansion of training centres on the above lines in close co-operation with the United Nations, with American agencies and with local university and governmental statistical services. A noteworthy idea in this connection is that some experts might remain after the close of a training centre to visit individual countries and help to put into practice the methods recommended.

As a step towards securing the participation of Governments in the 1950 World Census of Agriculture, the F.A.O. has issued a "Program" which gives an explanation of the proposal with specimen tables, definition of items, etc. The actual taking of the Census is a matter for individual Governments, but the object is to secure as far as possible identity of aim and method and thus promote the comparability of international statistics.

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CURRENT NOTES

Mr. R. B. Ainsworth, C.B.E., retired last May from his post as Director of Statistics at the Ministry of Labour, in which capacity he succeeded Mr. E. C. Ramsbottom some five years ago. For many years Mr. Ainsworth has placed his invaluable knowledge of labour statistics at the ready disposal of the Society, and we hope to have the advantage of his advice for many years to come.

The new Director of Statistics at the Ministry of Labour is Mr. R. F. Fowler, formerly of the Central Statistical Office.

It has been suggested that Fellows may be interested to know of the continued existence of the Royal Societies Club, which was founded over 50 years ago for the association in membership of Fellows and Members of the principal learned Societies, Universities and Institutions of the United Kingdom and Colonies.

The Club now occupies premises at 100, Piccadilly, W.1, and any Fellows who may be interested are advised to write to the Secretary at that address.

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ITALY—

Giornale degli Economisti e Annali di Economia—

July–August 1949—Le equazioni della dinamica economica nel caso più semplice del regime di monopolio della produzione delle merci: *G. Sensini.* Vecchi e nuovi problemi nello studio delle distribuzioni dei redditi: *V. Castellano.* Cenni sulla propensione all'importazione: *L. Diena.* Sul significato di alcune costanti statistiche: *M. de Vergottini.* Su un procedimento di calcolo per l'applicazione del metodo dei minimi quadrati: *V. Amato.*

Statistica—

October–December 1949—Interpretation of inequality between the comparative mortality figure (C.M.F.) and the standard mortality ratio (S.M.R.): *G. Herdan.* Premessa ad una teoria statistica delle combinazioni storiche ereditarie: *S. Vianelli.* Criteri metodologici per lo studio di gruppi soggetti ad interventi riparatori: *D. Miani-Calabrese.*

MEXICO—

International Journal of Opinion and Attitude Research—

Vol. 3, No. 3—The Opinion Polls and the 1948 U.S. Presidential Election: A Symposium (continuation)—Should we set up standards for poll critics?: *G. Gallup*; Comments of mass-observation on election forecasts: *R. L. England*; The informational failure of the Public Opinion Surveys: *M. Rosenberg.* Opinion research and public policy: *M. Kriesberg.* The moral implications of prevalence in the Kinsey Report: *L. P. Crespi.* Refusal rates and interviewer quality: *H. G. Heneman, Jr.*, and *D. G. Paterson.* Class consciousness of the American woman: *R. Centers.* Degrees of freedom in opinion research: *L. Guest.* Dimensions of a poll: *S. C. Dodd.* A comparison of the paper-and-pencil method and the radio method of polling public opinion: *M. Williamson* and *H. H. Remmers.* A Symposium on interviewing problems. The San Francisco program for improving standards: *E. Witt.*

Vol. 3, No. 4—How interviewer effects operate through question forum: *H. Stember* and *H. Hyman.* Opinion in relation to personality and social organization: *R. A. Bauer* and *H. Riecken.* The construction and operation of scalogram boards: *L. A. Kahn* and *E. A. Suchman.* Three tests for errors of report in a sample interview survey: *C. A. Metzner.* Value patterns in the Trade Union press: *M. Rosenberg* and *S. Bellin.* Verbi!: *R. C. Nuckols.*

SWEDEN—

Skandinavisk Aktuarietidskrift—

Part 3–4, 1949—Maximum likelihood estimation of the parameters of a normal distribution which is truncated at a known point: *A. Hald.* Contribution to the study of grouped observations. Application of the method of maximum likelihood in case of normally distributed observations: *N. F. Gjeddebæk.* Sampling distribution from a compound normal parent population: *H. Hyrenius.* Mortality data and the binomial probability law: *H. L. Seal.*

SWITZERLAND—

Schweizerische Zeitschrift für Volkswirtschaft und Statistik—

February 1950—Volkseinkommen und Sozialprodukt der USSR: *J. Rosen.*

INTERNATIONAL—

Revue de l'Institut International de Statistique—

Vol. 17, No. 3/4.—The twenty-sixth Session, Berne, September 5–10, 1949: *S. A. Rice.* National income estimates: *C. Gini.* Application of statistical methods to research and development in engineering: *B. B. Day.*

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LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part I, 1950, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Colonial Office
Colonial Annual Reports, 1948: Aden. 78 pp. 8¼″. 2*s.* 6*d.* Bermuda. 29 pp. 8¼″. 1*s.* 6*d.* Cayman Islands. 30 pp. 8¼″. 1*s.* 6*d.* Falkland Islands. 38 pp. 8¼″. 1*s.* 6*d.* Fiji. 87 pp. 8¼″. 3*s.* Leeward Islands. 52 pp. 8¼″. 2*s.* Malaya. 192 pp. 9½″. 7*s.* Northern Rhodesia. 67 pp. 8¼″. 2*s.* 6*d.* St. Vincent. 66 pp. 8¼″. 2*s.* London, H.M.S.O., 1949–1950.
Malta: recent requests for financial and economic assistance. (Colonial No. 253.) London: H.M.S.O., 1949. 14 pp. 9½″. 4*d.*

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Interim index of retail prices: indices for each section and group of items, June, 1947–May, 1949. 7 pp. (typewritten). 13″.
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Works, Ministry of, Chief Scientific Adviser's Division. Wages, earnings and negotiating machinery in the building industry, 1886–1948. i, 37 pp. (typewritten). 13″.

(b) Other National and International Publications

Australia

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communes rurales: Arrière-Pays de l'Ouest, 97 pp. Bassin Parisien, 97 pp. Centre Occidental, 81 pp. Centre Oriental, 105 pp. Centre Septentrional, 113 pp. Est, 113 pp. Nord-Est, 121 pp. Ouest-Atlantique, 97 pp. Paris, 1948–49. 10½″.

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Crop calendar. [Delhi], 1948. iii, 55 pp. 11″.

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United Nations Organization

Department of Economic Affairs

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The effects of taxation on foreign investments (1950.xv.1). iv, 87 pp. 9″. 3*s*. 9*d*.

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—— No. 3. De uitgaven van de gemeenten en de economische politiek der overheid, door Dr. J. Tinbergen. *Bestuurswetenschappen*, **3** (1949), pp. 197–203. 8 pp. 9½″.

—— No. 4. De problematiek der welvaartsplanning en haar ontwikkeling in de buitenlandse litteratuur, door Prof. Dr. Fred. L. Polak. *De Economist*, **96** (1948). 62 pp. 9½″.

—— No. 5. Government budget and central economic plan, by J. Tinbergen. *Public Finance*, **4** (1949). 11 pp. 9½″.

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Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART III, 1950.

Colonial Statistics

[A Discussion before the Royal Statistical Society held on March 22nd, 1950, Mr. H. Campion, C.B., Vice-President, in the Chair]

Opened by W. F. Searle, E. J. Phillips and C. J. Martin

Mr. W. F. Searle:

I. Introduction.—It is possible for three speakers to open this discussion and it will be possible for other Colonial Government statisticians to take part because a London conference of Colonial Government statisticians is in progress at the present time. This is the first conference of its kind and the representation is almost complete. I think everybody connected with the conference would agree that the timing is right; had it been much earlier neither the Statistics Department in the Colonial Office nor those in many of the major Colonial territories would have been ready to take part in the discussions, and had it been delayed we should have lost the advantages of pooling experience during the early stages of developing new organizations. Moreover we need a policy on priorities, standards of work and the adaptation of the normal methods of official statistics to Colonial conditions.

Until the opening of the conference a week ago few Colonial Government statisticians had met, although they had, of course, written to each other, and a number of them had had no personal contact with the statistical staff of the Colonial Office.

II. An Outline of the Present Position.—I am going to start by giving a brief account of the present scope of Colonial statistics, taking into account, as far as I can in my generalizations, the wide range of types of territories which are under the wing of the Colonial Office. By doing this I hope I shall discourage those who will be taking part in the discussion from making many references to past shortcoming. If Fellows of the Society are interested in the history of Colonial statistics they might like to read the paper entitled "Some Uses of Statistics in Colonial Administration" read by Sir Gerard Clauson to the Manchester Statistical Society in January, 1937,* in which he contrasted the situation as it was in the early 1930's with the great improvements which had been made by 1937. My account of the present position will then stand out as a record of a further advance.

Almost all the Colonial territories took a population census in either the late war or the early post-war years. Nigeria is an exception; if this is a skeleton it is certainly not in a cupboard and it would need a very large cupboard to contain it. There are good reasons for hoping that this gap will be filled in 1952. Some of the remaining small gaps can be explained by special circumstances, e.g. Gibraltar wanted its evacuees to return before taking a census. A Colonial census can be similar to one taken in the United Kingdom, for example, censuses in Malaya or the West Indies. In less developed territories, however, varying standards of enumeration have to be adopted and group enumeration with, perhaps, the recording of simple characteristics, e.g. the tribe, is all that is usually possible in the villages of such territories. The extent to which

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inquiries into ages, numbers of children, occupations, etc., are practicable is one of the major problems to be faced in planning a census in a Colonial territory.

In the West Indies, Malaya, and in territories like Cyprus or Mauritius, the rate of natural growth of the population is known, but evidence is only just becoming available in East and Central Africa and we still have little reliable knowledge of West African rates. You will not be surprised to hear that migration statistics are usually reliable so long as the emigrants and immigrants use the main ports. Movements across land frontiers are always likely to give a lot of trouble.

So long as agricultural production enters into what can be called wholesale trade quite a lot is known about it. Sometimes there are series of up-country purchases for exports (with related figures of stocks) even if full production estimates are not available. There are also partial records of food commodities like quantities marketed mainly for consumption in the towns. Plantations generally make returns and, as an extreme case, there are agricultural statistics relating to European settlers in East and Central Africa which are not unlike those of Western Europe or North America. As examples of gaps which are closing I might mention the present inquiries into the size distribution of small rubber holdings in Malaya and the surveys of cocoa farming in the Gold Coast and Nigeria which are the only good things arising from swollen shoot disease.

Estimates of the trend of food supplies in a territory as a whole, or in special areas, are still beyond us because of our lack of information on subsistence crops. In the West Indies, the questions on agricultural holdings and production which were included in the recent population census have added to our knowledge, but as yet little is being done by sampling to keep in touch with year to year changes. Efforts are made in Malaya to bring statistics of other food production up to the level so far achieved for rice. There are other exceptions and there are, admittedly, fragments of information from isolated detailed surveys but, broadly speaking, our knowledge of the output (let alone its utilization for food consumption) of subsistence crops is very scanty. Clearly, team work is needed here and the most important contribution of the Colonial statistics department may be in the design and analysis of sample surveys.

Statistics of livestock populations and the non-marketed proportion of livestock products are normally no more than broad estimates. In Africa there are great handicaps in the form of local opposition to counting and the misleading figures which arise from taxation payments based on the number of cattle owned. The paucity of data on fisheries can be seen from the few statistics in the recent report on the "Production of Fish in the Colonial Empire" (Colonial No. 237).

Minerals are usually produced in a small number of large operating units and it is not difficult to obtain the basic statistics. There are, however, still some outstanding problems on the metal content and valuation of the ores mined. Forestry statistics are normally reported in a standard form and do not seem to be an unsatisfactory indication of the situation in general.

Secondary industry is not highly developed in most Colonial territories and in these cases it is not difficult to obtain (though often not for publication) basic statistics of the output of the major products. In the few territories where secondary industry is now playing a more important part in the economy, information tends to be fragmentary and a census of production, perhaps in a simplified form, is becoming a possibility for the first time. The output of local craftsmen is a problem not unlike subsistence crops and I think it really falls within the field of general social surveys—a field in which the Colonial Universities and University Colleges are likely to do some very useful work.

Employment records are generally available but, apart from census data, the totals almost always refer to certain industries, or to employers other than the numerous small scale operators. The same limitations apply to the available records of wage rates. Certain unemployment records are liable to suffer from the troubles of all registration systems not connected with money payments—names tend to stay on the registers long after they should have been removed.

Returns of overseas trade are compiled by every colony, although a few minor colonies do not publish detailed reports. The quality of these publications varies and there are differences in the methods and basis of valuation and the classification of items. These anomalies and the risk of duplication through re-exports turn the compilation of aggregates for regions or for the Colonial territories as a whole into jobs requiring skill and imagination. Hong Kong and Malaya,

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which have a large entrepôt trade, find it impossible to distinguish between exports and re-exports. Users of Colonial trade returns (including, I may say, the Colonial Office) always regret the delay in their production. Presumably, local officials and business firms have early provisional figures and *ad hoc* analyses. On the basis of their trade returns a few of the larger Colonial territories produce indices of the value and volume of their imports and exports.

In most colonial territories cost-of-living indices are computed. They are usually based on an immediate pre-war or early war year and often relate to certain towns or population groups. In most cases they are based on budget surveys and follow the methods of computation used in the United Kingdom until the recent revision. A small number of Colonies have already adopted or will shortly be adopting post-war base dates. In general the difficulties of collecting reliable data on expenditure and price changes are greater than in more advanced countries both because of the greater shortage of staff suitable to undertake the work and because of the practical nature of the difficulties encountered.

There is a detailed estimate of the balance of payments tucked away in the introduction to the Jamaica annual trade returns for 1947 and similar estimates have been made for Northern Rhodesia. Other fragments exist but, so far, the bulk of the work on Colonial balance of payments has been done in London.

Readers of the United Nations' Statistical Office's report on "National Income Statistics 1938–1947" will be aware of the small amount of published work on the national incomes of the Colonial territories. Several other unpublished studies have been made and the first attempt to calculate the national income of Malaya is in a well advanced state. Jamaica and Kenya are at the stage when regular annual estimates are a practical possibility.

Other, perhaps less fundamental, forms of activity on economic statistics could have been included in this summary, but as I see the problem from the outside, it would not be easy for me to write a balanced account of the available material on the movements of people and commodities within each territory.

Any comments I might make on medical statistics would be of no interest to the specialists, but I must not complete this brief review without a reference to the new standard form for annual statistics on education which has been prepared by the Advisory Committee on Education appointed by the Secretary of State for the Colonies. It is too early to assess the effect it will have.

III. The Resources.—Let me describe the resources which are now available for the development of Colonial statistics by giving, first of all, the main facts concerning the staffs of the Statistics Departments of certain Colonial territories.

Table 1

Staff of Statistics Departments of certain Colonial Territories at end December, 1949

Territory	*Expatriate Senior Officers* (a)	*Senior Officers recruited locally*	*Clerks and their Supervisors*	*Machine Operators (including punchers)*	*Unclassified*	*Total*	*Statisticians on staff of other Departments*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Jamaica	..	3	17	6	..	26	1
Nigeria	6	2	56	28	13(*b*)	105	..
Gold Coast	4	..	6	7	17(*c*)	34	1
East Africa High Commission (Kenya, Uganda and Tanganyika)	7	1	115	24	15	162	2
Mauritius	..	3	6	..	..	9	½(*d*)
Singapore	2	4	54	16	2(*e*)	78	..
Federation of Malaya	1	1	81	..	5	88	..
Hong Kong	1	1	8	11	2	23	..

(*a*) Including Officers appointed before end December, 1949, but not in post at that date.
(*b*) Including 3 Statistical Assistants acting as Assistant Statisticians and a Powers supervisor.
(*c*) Including Organizations and Methods Officer, Systems Officer and Hollerith supervisor.
(*d*) The part-time statistician in the Department of Agriculture.
(*e*) Supervisor of Accounting Machinery and Librarian.

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A statistician was appointed to the Trinidad Government late in 1949 and another took up his post in Fiji early this year. Furthermore, Northern Rhodesia and Nyasaland have the services of the Central African Statistical Office which is run by the Director of Census and Statistics of Southern Rhodesia and his staff. As I expect many of you know, Southern Rhodesia has a strong statistical organization and the Colonial territories in Central Africa are fortunate in being able to draw on its resources and experience. Malta has recently expanded its statistics department by recruiting two young graduates. In Cyprus there is a considerable amount of statistical activity at present spread over the separate departments and in British Guiana the Economic Adviser is beginning to build up a statistical staff.

Recent Recruitment

Much activity in the Colonial Office over the past year is summed up briefly by figures of recent recruitment. Taking the posts in column (2) of Table 1 and adding those in Trinidad and Fiji, the position is that 15 out of these 23 officers were not in post at the beginning of 1949. These figures sum up, in the most effective way, our hopes for the immediate future. The most striking change has taken place in West Africa, where only two out of the present number of expatriate officers were in post at the beginning of 1949. To round off the story I must add that there were only two resignations amongst the senior expatriate officers during the period we are considering: both were women holding temporary appointments.

Other recruiters of statisticians might be interested in some details of recent recruitment, and I must admit that I found myself interested in the analysis. As it proceeds, recruiting is a succession of individual cases and it is difficult to see any patterns or generalizations until the results are tabulated.

First, as to basic academic training, we have the following particulars, from which are excluded a Home Civil Service Principal seconded to the Colonial Service and a senior Statistician from Jamaica transferred to Nigeria:

Oxford:	Modern Greats with a paper in Statistics . . .	1
Cambridge:	Economics Tripos, Pts. I and II	1
	Economics Tripos, Pt. II	1
	Mathematics Tripos, Pt. I and II	1
London:	M.Sc. in Statistics after first degree in Mathematics .	1
	B.Sc.(Econ.); Statistics as special subject . . .	2
	B.Com.	2
St. Andrews:	M.A. (Economics and Psychology)	1
Aberystwyth:	B.Sc., Agricultural Economics with Economics . .	1
Cape Town:	B.A.; B.Com.	1
Melbourne:	(Details not known)	1

Here are some further analysis of the whole 15 new recruits: 2 are women; 8 have had previous experience of official statistics; 4 have taken contract appointments whilst the remainder have been absorbed into pensionable posts; 2 were 40 years old or over at the end of 1949 and 5 were under 30; 2 came from the Dominions; 1 was in private employment in the territory to which he was appointed; and only 2 were inexperienced young graduates at the time of their appointment. The proportion of inexperienced young graduates will, I hope, rise considerably in the future, thus indicating that the statistics departments in the Colonies are becoming well established and able to provide for senior vacancies by promotions and transfers.

Extensive Developments

All the territories I named in an earlier section of this paper have a population of at least 300,000 and official revenue of at least £2,000,000 per annum. Excluding the population of the Aden Protectorates, which are not administered directly, we can ask what other Colonial territories

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fall within either or both of these limits without, of course, regarding the limits as necessarily having any significance. The answer is:

+ 300,000 *population*; + £2 *millions revenue*—
Sierra Leone.
North Borneo.

+ 300,000 *population only*—
Somaliland Protectorate.
Sarawak.

Sierra Leone will be disappearing from this list soon as those of you who read the advertisements in the *Times* are aware. As I wrote the preceding sentence I hoped it might be altered at the time of reading, but the appointment of a statistician has not yet been made. Plans are under discussion for the provision of a statistical service for both North Borneo and Sarawak. Somaliland Protectorate, on the other hand, falls so much below the £2 millions revenue mark that it is unlikely to be able to consider statistical work as a differentiated form of official activity. The only other Colonial territory which comes anywhere near the limits set above is Barbados (population 200,000; revenue nearly £2 millions) but to my knowledge no question of a statistical organization there has ever arisen.

The smaller Colonial territories numbering about a score, do not, of course, need statistics for administrative purposes as much as the larger territories. Nevertheless, they must and should produce some statistics and they need advice when they move away from fairly straightforward arithmetical totals such as imports or exports and do calculations like cost-of-living indices or food supply estimates. It should be possible, in some cases, for the statistics department of a neighbouring territory to act as a big brother, as Jamaica has done for British Honduras on agricultural statistics. Zanzibar can, in fact, always turn for advice to the East Africa High Commission. In other cases, the Colonial Office itself should be able to give some assistance, particularly when Colonial Service Officers are able to take part in discussions whilst they are home on leave.

Expert Advice

Men doing part-time statistical work in the smaller Colonies or a few statisticians in a larger territory spreading their energies over a large number of topics cannot expect to reap the advantages of specialization which are possible in a country like the United Kingdom with a statistical team in each of the major Ministries. Extensive work of this kind can, of course, be very attractive to some people especially when it is combined with the pioneering element in a Colonial job. It means, however, that advisory services are essential.

I hold no exaggerated views about the help which the Statistics Department in the Colonial Office can give to the Colonial Government Statisticians. At the very least it can ensure that useful techniques developed in any Colonial territory (or, if it is aware of them, in any part of the world) are well known in all the other territories. It should, and I hope it will, do rather more than this. Even if no advances in the methods of official statistics are made in Colonial territories there is a real problem in adapting the methods used in highly developed countries to the special conditions applying in Africa, Malaya, etc., and this in itself is a form of statistical specialization.

Of great importance are certain advisory posts which I have not yet mentioned. In the West Indies there is an Adviser on Vital Statistics, the cost of whose services fall on funds provided under Colonial Development and Welfare Acts. From the same funds it is proposed to create a new post at Rothamsted, under Dr. Yates, to advise on sampling problems arising in agricultural statistics as well as on the analysis of fertilizer trials. Colonial Development and Welfare money has also been used to finance a research project which was located in the Agricultural Economics Research Institute at Oxford, which has resulted in a stimulating report by Mr. Hunt on the development of agricultural statistics in the Colonies. I should also mention that the Colonial Economic Research Committee has an Advisory Panel on National Income Calculations which is always ready to help the statistics departments in the Colonies which are strong enough to make progress in this field. *Ad hoc* arrangements are always possible, such as Mr. Reddaway's recent visit to Cyprus during which he advised the Government on how to construct a new cost-of-living

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index on a post-war basis. Finally, though certainly not in order of importance, is the fund of advice (often on an informal basis) which reaches the Colonial Office and the Colonial Government Statisticians from the statisticians in the Home Civil Service, a number of whom are, at the present time, taking part in the Conference of Colonial Government Statisticians.

I have not yet mentioned the advisory work of the Statistical Office of the United Nations and of the Specialized Agencies. This is not because I do not value it highly, and a representative from the United Nations' Statistical Office is, in fact, attending the conference to which I have referred; it is because these are advantages which we share with statistical organizations throughout the world.

Intensive Developments in Existing Statistics Departments

The most satisfactory way to look at intensive developments would be to approach them as they arise in practice—what further tasks should be undertaken by the statistics departments in the Colonies and what additional staff do these imply? Practical decisions, however, are made gradually which is a very different matter from trying to foresee what is desirable and practicable over the next few years, especially as this also involves an assessment of the extent to which existing work may demand less attention from senior staffs.

For my own benefit I worked out some months ago a rather rough alternative approach which I am including in this paper because I think you will agree that it throws some light on the present position of the existing statistics departments and gives some indication of what staffing aims might be.

Two basic assumptions must be faced:

(i) that, within the range of type and size of territories we are considering, the need for statisticians is in proportion to the need for central administrative staff; and

(ii) that, again within the range under consideration, a territory forced by revenue considerations to curtail its central administration will curtail its staff of statisticians in proportion.

You will notice that I have referred to statisticians and not to the total staff of statistics departments. The latter is an impossible guide because the total staff varies considerably according to whether detailed work (e.g. the preparation of trade returns) is undertaken partly or entirely in the statistics department or whether it falls within the scope of other departments.

There is very little I can say to justify the assumptions. I do not think (i) is unreasonable—it certainly prevents the mere size of a territory from having too great an influence on the assumed need for statisticians—and the second assumption has, at least, the great virtue of suppressing unrealistic views as to the amount a Colonial territory is willing to spend on its statistics department.

Before applying the assumptions in the table below I must define "central administrative staff." In the Colonial territories it is the number of Administrative Officers in secretariats or in the separate departments plus the directors, deputy directors and assistant directors (or their equivalents) of these departments but excluding comparable grades of staff concerned with legal matters, prisons, the police and statistics. The definition fits the African territories best but it can be applied without much uncertainty to the remainder.

Both Jamaica and Mauritius have statistics departments which have been in existence for some years and you will, I am sure, connect the relatively high percentage for Jamaica with my earlier references to that territory during my brief review of work such as balance of payments and national income. I should add, however, that electoral registration work falls on this department and therefore its strength is exaggerated by its high percentage. The wide scope of statistical work in Mauritius stands out clearly from its recently published *Yearbook of Statistics, 1948*.

The African territories are, perhaps, not quite as near to each other in statistical developments as the percentages would suggest. The department in East Africa has a longer history than the West African departments and some work is therefore on a well established basis. Moreover the statistics department in Nigeria is still facing the heavy burden of a population census. I suspect that assumption (ii) must not be overlooked in trying to interpret the percentage for Nigeria.

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TABLE 2

Senior Statistical Staff in Certain Colonial Territories in Relation to the Central Administrative Staff

Territory (1)	*Senior staff as in Cols. 1, 2, and 6 of Table 1* (2)	*Vacancies* (3)	*Total (2) and (3)* (4)	*Central administrative staffs* (5)	*Col. (4) as a percentage of Col. (5)* (6)
Jamaica	4	..	4	55	(8)
Nigeria	8	(*a*)	8	205	4
Gold Coast	5	1	6	125	5
East Africa High Commission	10	2	12	285	4
Mauritius	3½(*b*)	..	3½	45	(8)
Singapore	6	..	8	190	4
Federation of Malaya	2	..			
Hong Kong	2	..	2	75	(2½)

NOTE.—The percentages for Jamaica, Mauritius and Hong Kong have been put in brackets because of the small numbers in col. (5).

(*a*) Not yet determined.

(*b*) The part-time statistician in the Department of Agriculture has been counted as one-half.

There is an outstanding shortage of trained personnel in Hong Kong to analyse and develop the considerable body of basic data collected and published. In Malaya both statistics departments have a narrower range of functions than is normal nowadays and the percentage indicates that it would be difficult for them, in present circumstances, to widen their activities.

I wish I had comparable figures for statistics departments in other parts of the world to put against those in Table 2. I have, however, two further examples, both of which throw light on the level of staffing which seems to be necessary for a thriving statistics department. The record of the statistics department in Palestine is known to be a good one, and if the 1939 staff position had been included in Table 2 the figure in col. (6) would have been the highest of all (10 per cent.), based on 5 in col. (4) and 50 in col. (5). My second piece of evidence is the present position in Southern Rhodesia. The senior staff of the Central African Statistical Office is a strong one and consists of 12 professional officers and 3 administrative assistants, but the total must be reduced to 12 to allow for the work done for Northern Rhodesia and Nyasaland.* There are approximately 240 officers other than in the statistics department who can be regarded as within the grades comparable to those included in the central administrative staff in Table 2† and therefore Southern Rhodesia might give its percentage as 5. Administrative staffs in the following Southern Rhodesian departments, however, should be excluded if its figures are to be put on the same basis as those for the Colonial territories—Native Affairs (apart from administration), Police, Prisons, Defence, Justice, High Court and District Courts and Deeds. The percentage then becomes 7.

I must resist the temptation to draw a positive conclusion from data which may not be capable of supporting it. It seems certain, however, that a statistics department in the Colonies working at a staffing level, as defined above, 4 ± 1 per cent. is not strong enough to make rapid progress and that it must neither work too intensively on any subject nor overload the machine by taking on too many subjects. An acute sense of priorities is all important.

Local Recruitment

It may well be that intensive developments turn, to some extent, on the possibility of more well-trained local recruits becoming available over the five or ten years. In the short run, the most important training ground is the British Universities and the number of Colonial students at the present time taking relevant courses is given in the following table.

* Total expenditure in 1949/50 estimates £47,000; contributions by N. Rhodesia and Nyasaland £9,500.

† Administrative Officers, Administrative Assistants Grades I and II, and Senior Professional Officers Grade II or above.

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TABLE 3

Students from Certain Colonial Territories in British Universities, Year 1949/50, taking Degrees in Economics, etc., Commerce or Mathematics

University and courses	*Trinidad*	*Jamaica*	*Nigeria*	*Gold Coast*	*Kenya*	*Tanganyika and Uganda*	*Malaya*
Oxford:							
Modern Greats	..	..	1	2	3	..	..
Cambridge:							
Economics	1	..	1	2	1	2	1
London:							
B.Sc.(Econ.)	3	3	4	3	1	..	1
B.Comm.	..	..	..	1	..	..	..
Higher degrees	1	..	..	1	..	..	1
Other Universities:							
Economics and Commerce degrees	..	2	3	8	2	..	7
University Colleges:							
B.Sc.(Econ.)	..	1	2	1	2	..	1
B.Com.	..	..	1	3	1	..	1
All Universities and University Colleges:							
Mathematics	..	1	4	4	1	1	1
Total	5	7	16	25	11	3	13
Scholarship holders	3	5	11	18	4	2	8
Private students	2	2	5	7	7	1	5

NOTES:—

(1) Seven colonial students are preparing for B.Sc.(Econ.) and B.Com. degrees in technical colleges.

(2) Three students from Nigeria and one from the Gold Coast are working for the B.Com. degree in Dublin.

I should be surprised if any of the mathematicians were interested in statistics and some of the other groupings are too wide. For example, the B.Sc.(Econ.) students in London University from the territories set out in the table can be classified as follows:

Inter stage		4
Finals:		
Special subject Statistics	3	
,, ,, Economics	1	
Other special subjects	7	
	—	11
Total		15

Thus on the basis of the existing specialization for finals only about a third are within the field we are considering.

The figures in Table 3 represent about three years output from British Universities. Although statistics departments do not need many recruits, appointment to them will be merely one of the many opportunities, both official and private, open to the successful graduates from this bunch of students. I would put the likely number of recruits to statistics departments at a very low figure. The West Indian territories are in the happy position of having two B.Sc.(Econ.) students specializing in statistics: scholarship holders from Jamaica and Trinidad. As suitably trained graduates from Canada and the U.S. are much more likely to be found in the West Indies than in any other Colonial territory, local recruitment there is likely to fill almost all, if not all, the vacancies.

The recent Nigerian report on "The Recruitment and Training of Nigerians for Senior Posts in the Government Service of Nigeria" which was accepted in principle by the Government, sets

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out very clearly how the problem of advanced training appeared to the Commission, which consisted largely of Senior Colonial Service Officers and members of the Legislative Council or Houses of Assembly. The Statistics Department was one of the departments listed as "where an Honours degree is desirable" and its needs were taken into account in a three-year scheme for 100 scholarships for education and general degree courses. Of this number, however, the Commission recommended that 60 should be reserved for potential school teachers and a further 15 for teachers' training courses. Thus senior recruits for the Statistics Department take whatever share is practical of 25 scholarships over 3 years.

We are faced with a position which is essentially the same as for the Colonial Service generally and this has been set out as follows in Sir Charles Jeffries's new book on the Colonial Service, *Partners for Progress*:

> "It is when we get to . . . jobs requiring either a university degree or some special post-secondary training, that we find the Colonies still needing help from outside. The reason . . . is simple. Up to now the only full-scale universities in the Colonies have been those of Malta and Hong Kong. A university is now being started in Malaya and university colleges are being established for the first time in the West Indies, and developed out of existing institutions in West and East Africa. In time large numbers of colonial graduates will be forthcoming to take over a variety of jobs—but in time. The colleges have to be set going, buildings, staff, and equipment provided and after that some years must pass before a large-scale output can be expected."

I understand that none of the Colonial universities or university colleges can at present provide full, specialist training in statistics, or is likely to be able to do so in the near future. They all provide degree courses in mathematics. Some, such as the University College of the Gold Coast, offer degree courses in economics.

The University of Malaya has recently appointed to its department of economics a lecturer in statistics, but, encouraging though it is, even this does not mean that the University can yet train specialist statisticians. It would seem, therefore, that for the present the Colonial student must seek his training as a statistician overseas, either through a full degree course or through supplementary training in the case of those who have read mathematics or economics in first degrees at their local universities or colleges.

Clearly it would be premature to attempt to strike a balance between the possibility of local recruitment and the continuing need for Statisticians for the Colonial territories to be recruited in this country and the Dominions. As the situation develops the problem will have to be faced and Sir Charles Jeffries has outlined a solution as a reasonable guess concerning the future of "highly specialized branches of the Service" likely to have wider applications, namely, "that some Colonies, at least, may even come to prefer that all expatriate officers should serve on central-service terms and be pensionable from the central fund." This is envisaging a pool of statisticians undertaking various tasks in the Colonial territories, running the statistical services of some but in others merely filling up deficiencies after local recruitment has provided the bulk of the staff. The officers concerned would expect to move between territories and possibly also into and out of other kinds of public or semi-public services.

IV. Balance of Payments.—Before my colleagues from the Colonial territories describe, in more detail, certain aspects of their work, I want to refer briefly to balance of payments calculations because I regard them as a special case. All other developments of Colonial statistics will be centred in the Colonial territories, with London helping if it can by playing an advisory role. Balance of payments work, in contrast, seems to me to be essentially a matter for joint activity. There are four reasons for this:

> (i) Since the work involves external financial relationships and the most important of these for almost all Colonial territories is with the United Kingdom, much of the material required for Colonial balance of payments calculations is the same as, or should be reconciled with, the corresponding figures in the detailed calculations for the United Kingdom.
>
> (ii) As London is the centre of the Sterling Area, much of the relevant statistical material on banking transactions and exchange control operations is available in London sooner, and occasionally in a more comprehensive form, than in the Colonial territories.

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(iii) If it is possible to obtain assistance from the larger firms operating in the Colonial territories, some of whom are active in several territories, it may be an advantage to ask for this assistance in the form of a single request to their head offices rather than to make separate requests in each of the Colonial territories concerned.

(iv) Many of the items required in a detailed balance of payments working sheet will, for the time being at least, involve skilful estimates. In London it should be possible to keep all these estimates in line and to draw on material provided by one territory in making estimates for another.

Looking into the immediate future, I can visualize a system under which the larger Colonial territories would start the compilation of balance of payments tables covering, say, each half-year's transactions. This material would then come to London where the appropriate "London" items would be added. It would then be studied in relation to the data in the United Kingdom calculations and any information available from U.S., Canadian or other sources, and estimates would be inserted, if possible, for the missing items thought to be significant. The tables, completed to this extent, would then go back to the Colonial territory, and, after some argument perhaps, an agreed final version would be in the possession of both London and the Colonial capital. The larger the share of this joint activity undertaken in the Colonies the happier, I am sure, the London end would be.

If this system could be operated there is much to be said for adopting the summary table recently prepared by the International Monetary fund for the use of member countries in respect of "dependent overseas territories" and for the related detailed working sheets. Figures for many member countries are already being published along the lines laid down by the International Monetary Fund, and others are moving that way.

I am not an expert on balance of payments work but when I study the items in the detailed International Monetary Fund working sheets I do not feel hesitant about the ability of the partnership to make a reasonably good shot at them except for the item of private capital movements. Although there are other parts of this item which would not be at all easy to estimate it seems probable that the most difficult would be financial movements between the branches of business firms resident in Colonial territories and their head offices overseas. Using International Monetary Fund definitions all enterprises in a Colonial territory (except agencies) would be regarded as resident even though they were branches of subsidiaries of non-resident firms. If the larger firms involved would agree to help in the preparation of the estimates many of the problems would disappear. I have no idea, of course, whether this would be practicable although I have strong hopes that it would be; in any case, I am outlining personal views of the way Colonial balance of payments work might be developed.

Mr. E. J. Phillips:

V. Foreign Trade Statistics.—In introducing the subject of Foreign Trade Statistics, I speak from practical experience in Malaya and I do not claim an intimate knowledge of trade statistics in other countries. However, my comments are designed to be of general interest.

Uses of Trade Statistics

A good approach to a discussion on trade statistics is, I suggest, to consider what are their practical uses in the field of national statistics. They are used, either by themselves or in conjunction with other statistical information, to make estimates of production, consumption, balance of payments or import and export price movements. They form a basis for import programmes or import and export quotas. They indicate the effect, on trade, of changes in Government policy. They provide a guide to commercial enterprises in regulating their activities. They influence the planning of schemes for the development of communications or port facilities. They may be considered by international organizations in course of their deliberations. They have other uses but this list will serve to indicate, not only the importance of trade statistics over a wide field but, also, the need for keeping them in line with developments in a constantly changing world.

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Original Data

The original data on importers' and exporters' declarations usually include particulars of country of origin or destination, port of shipment, description of goods in such detail as will enable their correct classification according to the import and export list, the registration of quantity in appropriate units and of value in terms of national currency. These particulars are the foundations on which trade statistics are constructed and the uses which can eventually be made of the statistics are, from the outset, limited by the definitions, scope and accuracy of the declarations. Subsequent statistical analysis may also be restricted by limitations of staff and equipment but where a punch-card mechanical tabulation system is available, a high degree of flexibility can be attained. In this connection it is desirable that the maximum amount of information obtainable from the original declarations should be recorded on the card, even if a part of it is not immediately required for routine tabulations. In Malaya, it has been possible on several occasions to supply information at very short notice from particulars latent on the cards.

Imports: "Country of Origin"

A prerequisite to the compilation of trade statistics is to arrive at practical definitions of country and of value and to arrange that details are consistently entered on the import and export declarations in accordance with these definitions. It is obvious that if there is any confusion between country of origin and country of consignment or between C.I.F. (cost, insurance and freight) and F.O.B. (free on board) values any statistics originating therefrom cannot be reliably interpreted. As in all statistics the first care of the statistician must be the accuracy of the original documents and this cannot be too strongly stressed. In Malaya, imports are recorded and compiled by country of origin, namely, the country where the goods were produced, manufactured or transformed into their existing condition. The information is checked against suppliers' invoices and, when considered necessary, by reference to certificates of origin or by physical inspection. The country of consignment, that is the country from which the goods were originally despatched without any commercial transaction in any intermediate country, is generally but not always indicated by the port of shipment. For example, goods may be consigned direct from, say, Switzerland and shipped from a port in France or Italy. When the country of consignment is indicated the information may be extracted, if required, as in the case of goods of U.S.A. origin imported into Malaya from Hong Kong. In this instance, both the country of origin and the country of consignment are shown in the statistics, the figures published showing the value of U.S.A. goods imported from Hong Kong. For the most part the country of origin and the country of consignment are identical.

Exports: "Country of Consignment"

In regard to exports, it is unfortunately not possible to adhere consistently to a single definition of country because the country of consumption and, where optional ports are declared, the country of consignment may not be known at the time of export. For example, rubber and many other articles of produce are frequently shipped to one country and at a later date the consignment may be re-exported in whole or in part before arrival at the country of consumption. It is therefore quite impracticable to trace consignments to their final destination and, even if it were possible, the time lag would prohibit any adjustment to current statistics. The country of consignment, that is the country to which the goods are despatched, is generally known except when the goods are shipped to the order of a buyer who names several optional ports in different countries as possible ports of unloading. The country of consignment may thus not be decided upon till after the goods have been shipped and may, in fact, never be known at the country of export. There is consequently an unavoidable inconsistency in export statistics as compiled by countries and this fact should be borne in mind when assessing their reliability. This weakness does not apply equally to all trade routes and all countries. For example, goods exported from Malaya to the United States of Indonesia, Borneo, Australia and several other countries are nearly all consigned direct to and consumed in those countries.

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Valuation of Imports and Exports

The definitions in general use for trade values are "cost, insurance and freight" for imports and "free on board" for exports. Import values as declared are checked against suppliers' invoices when available and, if the goods imported under a single invoice are classified under more than one heading, insurance and freight are apportioned. In the case of goods accompanied by the owner or imported from neighbouring countries on a cash or barter basis, the declared values are checked against current market values. Goods consigned for sale are recorded at the latest sale value. Declared export values are checked for apparent discrepancies against the average export values at the time of export and/or market values. The values of imports and exports by parcel post are largely estimated on the basis of sample surveys showing average values by countries of despatch or consignment.

Classification of Commodities

An important phase in the compilation of trade statistics is the classification of commodities. Import and export lists differ considerably throughout the world in the description of individual headings and in the definitions of groups and classes. Standard lists for international use have been prepared in the past but they have not yet been universally adopted. A revised standard list is now under consideration by the United Nations Statistical Commission after consultation with Member Governments. International comparability is obviously desirable in international trade statistics and the adoption of uniform principles in classification would facilitate reference to and interpretation of such statistics. Complete rearrangement of an established list which has been in use for many years is, however, a task of considerable magnitude, involving problems of adapting the new list to local conditions, of re-classifying individual articles, of maintaining continuity with earlier statistics, and of training staff to a new system. It is, therefore, essential that the framework on which the list is constructed should remain static over a period of years and that any interim amendments should be mostly confined to individual headings. The Malayan import and export list follows the principles on which the United Kingdom lists are constructed. The grouping is similar and the headings are similarly defined except where they have been modified to suit Malayan trade. In the periodical revision of the list the headings are amended where considered necessary after consultation with trade associations and Government departments. This revision is designed to keep the list up-to-date with changing patterns of trade, to eliminate any anomalies or ambiguities that may be discovered, to meet official requirements, and to assist the trading community with information required for their businesses. To obtain additional flexibility in classification a column is reserved on the tabulation card for a sub-heading code. It is thus possible to effect a breakdown of any particular heading into several sub-headings for the purpose of a special enquiry without interfering with routine tabulations. A practical example is the subdivision of the heading "Rubber for Remilling and Smoking" into (1) Unsmoked Sheet, (2) Wet Sheet, and (3) Scrap, Lump and Bark, for the purpose of a special return.

Classification of Countries

The list of countries shown separately in the statistical returns may from time to time require amendment to conform to geographical changes as, for example, the reconstitution of British India into the Republic of India and Pakistan. Development of trade may also make it worthwhile to amend the list by showing separately a country which had previously been included under a group comprising several countries. In Malaya, the countries selected for separate compilation are those with which the volume of trade is significant, and they are arranged by continents with Commonwealth countries grouped together. The trade with the United States of Indonesia, which is especially important to Malaya, is further sub-divided into eight areas and a still further analysis is made to show the trade by specified U.S.I. ports.

Effect of Constitutional Changes

The constitutional changes in Malaya have brought about some amendments in the compilation and presentation of Malayan foreign trade statistics and, although this is a matter primarily of interest to Malaya, it illustrates the incidence of internal as well as external territorial changes.

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As it happens, the trade registration area covering Singapore and the Federation of Malaya remains unaltered except for the exclusion of Labuan which is now included with North Borneo. The effect of this exclusion is negligible and post-war and pre-war figures are therefore still comparable. The revised compilation and presentation have been arranged to provide separate figures for Singapore and the Federation of Malaya as well as pan-Malayan totals.

Method of Compilation

As already stated, the interpretation and reliability of trade statistics are, in the first place, limited by the information which appears on the original documents. Within those limits, the final tables made available, either in periodical publications or as special returns, depend largely on the method of compilation used. Experience has shown that manual compilation is considerably more restricted in flexibility than mechanical tabulation and that the latter method is to be preferred whenever facilities are available. Every particular recorded on a punch-card is equivalent to an entry by hand on a register. The cards can be sorted and tabulated in many different ways and the tabulator can be designed to produce sub-, grand and cumulative totals at a single operation. Thus, with a single passage of the cards through the tabulator it is possible to produce, in the sequence of the import and export list, figures showing:

(1) Monthly quantities and values of imports or exports of each commodity heading by individual countries and also for all countries.

(2) Corresponding cumulative totals from the beginning of the year.

Similarly, by a rearrangement of the cards, a single tabulation can produce figures of trade with each country by commodity headings and groups, together with cumulative totals. The production of Malayan trade statistics in their present form, showing separate figures for Singapore and the Federation of Malaya as well as pan-Malayan totals, provides a good example of the flexibility of mechanical tabulation. This method of compilation is particularly useful when statistical information is required for a special inquiry in some form not available in the regular publications because the relevant cards can readily be extracted, sorted and tabulated with little inconvenience and delay. Any departure from routine in the case of manual compilation usually involves diversion of staff for the purpose.

Presentation and Publication

The form in which foreign trade statistics are presented and the frequency with which they are published vary considerably in different countries. The aim is generally to publish monthly import and export figures for each heading on the classified list together with summaries showing class and group totals and trade by countries. If possible, import and export statistics are analysed by countries of origin and destination. Trade in commodities of much importance to national economy may justify special advance returns as for rubber and tin in Malaya. If monthly statistics cannot be compiled in the detail desired the deficiencies may be met by quarterly publications. The publication of cumulative totals with monthly or quarterly figures automatically provides annual trade statistics in the issue covering December. Cumulative totals are also a convenient medium for the correction of errors discovered in earlier publications relating to the same year. Apart from monthly or quarterly publications, there is a need for an annual statement giving comparative figures with earlier years together with a more detailed analysis of trade statistics than would be practicable or justified in monthly or quarterly statistics. For example, trade by ports of entry or shipment, trade with principal countries by commodity headings, trade in principal articles of merchandise, and trade by nationality of carrying vessel may be compiled as useful material for inclusion in an annual publication.

A problem which presents some difficulty is how to reduce the lapse of time between the completion of tabulation and the issue of the publication. In Malaya, some time is saved by arranging that only the figures of quantity and value and the period to which they relate have to be typeset on each occasion. The figures are typeset direct from the tabulation sheets which are forwarded to the printer as they become available. Unfortunately, it is difficult to eliminate all type-setting errors during the proof-reading stage, particularly if the publication is bulky. In this connection, it is interesting to note that monthly publications on trade statistics have already been reproduced directly from tabulation sheets by the photo-litho method of printing.

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Entrepot Trade

Finally, I would refer to specific problems which arise in connection with the entrepot trade at the free ports of Singapore and Penang. These ports are collecting and distributing centres for the produce of Malaya and also for identical kinds of produce originating in the United States of Indonesia, Thailand, North Borneo, Sarawak and other neighbouring countries. In the absence of import and export duties at the ports, there is no purpose in keeping stocks of domestic produce separate from those of imported produce. In fact, it is often more profitable to mix and grade all available supplies together, irrespective of origin, notwithstanding possible advantages which may be derived from preferential rates of duty. This, for example, is the most economical method of handling relatively small bundles of rattan canes, as each bundle may include several species and grades of cane. It is also advantageous to remill imported and domestic rubber together but, even when no treatment or mixing takes place, change of ownership, which is a frequent occurrence while goods remain in the entrepot ports, makes it difficult to identify with certainty the country of origin of individual consignments at the time of export. Although statistics cannot be compiled from original data to show imports for consumption, domestic exports by destination or re-exports by country of origin, total figures of retained imports and of re-exports can be deduced with reasonable accuracy for certain commodities in respect of which either the internal consumption or the domestic production is negligible in relation to total trade. In the extreme case of no internal consumption it may be presumed that all imports are re-exported and if there is no domestic production all exports must be re-exports. If commodities are both produced and consumed locally to a significant extent it may be difficult to make reliable deductions in regard to retained imports and re-exports.

In addition to entrepot trade considerable quantities of merchandise pass through the ports of Singapore and Penang as transhipment trade. This is defined as trade on through bills of lading in transit from one non-Malayan country to another and remaining in the custody or control of shipping and airline agents while awaiting transhipment. In the past it has been decided that statistics of this trade should not be compiled in Malaya. In some instances entrepot trade may pass through the ports with little more handling or commercial transaction than transhipment trade, but the above definition is found to provide the most practicable line of demarcation.

Mr. C. J. Martin:

VI. East African Population Statistics.—*Introduction.*—One cannot discuss before this Society population statistics in any part of the Colonial Empire without making reference to the great studies carried out by the late Dr. R. R. Kuczynski, late Demographic Adviser to the Secretary of State for the Colonies. Volume II of his last work, *A Demographic Survey of the British Colonial Empire*, provides a full bibliography of all population data on East Africa available to 1946, and it has been a great disappointment to me that the results of the 1948 East African Census were not available before Dr. Kuczynski's death, so that I could benefit from his knowledge and comment. In Volume II, Dr. Kuczynski pointed out that it was impossible to state conclusively the trend of population in East Africa and this statement is still fundamentally correct.

East Africa is a term which embraces a varying number of territories. For the purpose of this paper, however, East Africa is defined as the territories forming the East Africa High Commission, i.e. Kenya Colony, Tanganyika Territory, Uganda Protectorate and, in addition, the Protectorate of Zanzibar. The mainland territories cover an area of some 640,000 square miles while the Protectorate of Zanzibar consists of the two densely populated islands of Zanzibar and Pemba.

Previous estimates of population.—It has been the custom of certain governments in recent years to estimate population on the basis of the number of tax-paying males. In earlier years, direct taxation was in the form of a hut tax and was, therefore, related more to the number of wives than to the number of adult males. But in recent years, the calculation of total population has been made in various ways. In Kenya it is based on factors for women and children, and in

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Tanganyika on the average number of dependants per adult male. In Uganda, the estimates have been based on counts adjusted by statistics obtained from the birth and death registers.

In 1931, counts of varying orders of accuracy were undertaken in some of the East African territories. In Uganda, an attempt was made to count the total population in one day and various characteristics were requested. The schedule used was a group enumeration by villages and difficulties were experienced. In Tanganyika, an attempt was made to count the total population over a period of time and, generally, this count consisted of a better analysis of the poll tax registers. In Kenya Colony, no attempt at a census or detailed count was made. Table 1 shows the statistics obtained from these earlier counts compared with the population census results of 1948. The Government of the Protectorate of Zanzibar undertook a family survey in 1931, and by means of this count an estimate of the total population was made; this estimate for Zanzibar was probably more accurate than those for the other territories.

TABLE 1

African Population. Comparison of 1931 *Counts and Census Results*

Year	*Tanganyika*			*Uganda*		
	Male	*Female*	*Total*	*Male*	*Female*	*Total*
1931 Count . .	2,428,000	2,594,000	5,022,000	1,690,000	1,835,000	3,525,000
1948 Census . .	3,519,000	3,813,000	7,332,000	2,457,000	2,460,000	4,917,000

Birth and death registration.—The registration of births and deaths is compulsory for Europeans throughout the East African territories and for Asians in Kenya, Uganda and Zanzibar. In Tanganyika Territory, death registration alone is compulsory. Uganda and Zanzibar have systems of registration for the African population but, although the organization exists, the statistics are not complete.

Problems of enumeration.—In contributing to this discussion I can deal only with the major problems facing the enumeration of a population in an undeveloped area. They consist of the following:

(*a*) Size of territory; (*b*) scatter of the population; (*c*) mobility of the population; (*d*) literacy of the population; (*e*) supervision; (*f*) finance; (*g*) natural suspicion.

The main problem is to ensure that the total population is counted in the shortest possible time and for this reason a very simple schedule is necessary. The African Population Census of the mainland territories was undertaken in August, 1948, and by using some 25,000 enumerators it was possible to count the total population by sex, age groups and some 4,000 administrative units. The method of enumeration was by a family survey, the enumerator visiting each household to obtain the necessary particulars. After the general census was completed, a sample census of some 10 per cent. of the population was undertaken on an individual enumeration basis, and this census provided information on the main characteristics of the population.

The non-native population of the mainland territories, although not large numerically, is economically important. Fortunately, the majority are to be found in towns or special areas, and the census was undertaken on February 25th on an individual basis. The total census of the Protectorate of Zanzibar was taken at the same time, an individual enumeration being made. In this Census, more statistical information was obtained of the African population than in any other territory of East Africa.

Results of the census.—The first major result of the African Population Census was the discovery that the total numbers had been underestimated in the last official estimates to the extent of nearly 4 million. As Table 2 shows, no degree of wishful thinking can permit a study of population growth to be made by comparing the estimates and the census results. It is interesting to observe that the change in population was roughly the same in each territory. The age group analysis by territory was not consistent and that for Uganda Protectorate appeared the most accurate. The system of birth and death registration throughout the Protectorate may be in part responsible for the result. In the other territories, the number of children classified as "under one" appeared to be too large.

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TABLE 2

Comparison of Estimated Population of 1947 *and Census Totals* 1948

Territory	*Estimated Population* 1947, *Total*	*Census* 1948, *Total*	*Absolute difference*
Kenya Colony	4,055,000	5,373,000	1,318,000
Tanganyika Territory	5,917,000	7,332,000	1,415,000
Uganda Protectorate	3,967,000*	4,917,000	950,000
Total	13,939,000	17,622,000	3,683,000

* End 1946.

Population growth (*Non-native*).—A great deal has been written on the subject of population growth in East Africa, both of the African and non-native communities. In the study of the non-African population growth two major factors have to be considered: (*a*) natural increase; (*b*) immigration. Although immigration in most countries is not important, in East Africa it has a major effect on any general calculation: at the time of the Census, the European population included 80 per cent. who were born outside East Africa, while 63 per cent. of the Indian and Goan communities reported birthplaces overseas. Immigration statistics are not accurate, especially for persons arriving by land routes, but some idea of immigration of a permanent nature can be obtained from a study of Table 3, which shows the number of permanent immigrants reported entering Kenya Colony each year since 1946.

TABLE 3

Kenya Colony. Reported New Permanent Immigration
(Excluding Visitors and Persons in Transit)

Year	*Racial origin (numbers)*			
	European	*Indian, Goan and Arab*	*African and Other*	*Total*
1946	3,509	2,971	69	6,549
1947	5,040	4,710	82	9,832
1948	6,501	5,738	89	12,328

It is impossible to obtain an estimate of the natural increase of the non-African population from a study of birth and death registration, the statistics not being complete. In an attempt to collect information, questions on fertility were included on the population census schedule, and Table 4 (*a*) and (*b*) describes, by territory, the main statistics compiled for the European population. The small numbers and the importance of immigration prevent any accurate statement being made concerning population growth, but the present population is concentrated in the middle age-groups and thus the same fertility pattern, without immigration, would result in a decline in the population. It is perhaps wrong to take 15 years as the lower limit in Table 4(*b*) but this was done for comparability. For calculation of fertility rates the year 20 was used.

The Indian community shows a very high birth rate and a low infantile mortality rate. For the mainland territories, the birth rate has been estimated to be in the order of 40 per thousand of the population and infantile mortality at 85 per thousand live births. Gross fertility of women who have completed their child-bearing is in the order of 6, with slight variations between the territories, and in the younger age groups the number of live births is even greater.

Tables V(*a*) and (*b*) provide statistics showing average fertility by age groups, and also size of family. The total Indian population appears to be increasing at the rate of about 2·5 per cent. per annum and a net reproductive rate of 1·9 to 2·2 has been calculated. Comparisons with statistics of Indian population in other areas show that gross fertility is roughly the same, but the standard of living being much higher, the death rates are substantially below those found in other areas.

In Table 5(*b*) there is a high percentage of childless women 15–44 years. The majority of these are 15–19 years and unmarried.

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TABLE 4(*a*)

European Population
Total Live Births per Woman and Infantile Mortality Rates by Territory and Age Group*

Age group in years	*Kenya*		*Tanganyika Territory*		*Uganda*	
	Live births per woman	*Infantile mortality rate**	*Live births per woman*	*Infantile mortality rate**	*Live births per woman*	*Infantile mortality rate**
15–19	..	..	0·1	..	..	..
20–24	0·4	28	0·5	..	0·5	40
25–29	0·9	35	0·8	51	0·8	24
30–34	1·3	37	1·1	32	0·9	25
35–39	1·4	40	1·2	45	1·1	33
40–44	1·4	40	1·3	61	1·1	57
45–49	1·5	45	1·1	64	1·1	47
50–54	1·6	41	1·5	60	0·9	82
55–59	1·7	55	1·7	79	0·8	28
60–64	1·9	54	1·9	105	1·4	45
65–69	2·2	51	1·8	..	1·1	37
70–74	2·4	69	2·3	..	1·3	50
75–79	2·6	57	1·6	..	..	..
80 and over	2·6	64	1·7	..	..	..

NOTE.—For Uganda these rates are calculated from the experience of a very small number of women.

* Deaths per 1,000 live births. The rate is based on number of children who died under one year of age to total live births at time of census.

TABLE 4(*b*)

European Population
Distribution of Women 15–44 Years by Number of Live Births

Territory	*Number of live births (percentage)*									
	0	1	2	3	4	5	6	7	8	9 *and over*
Kenya	49·6	19·9	17·0	8·6	3·0	1·0	0·4	0·2	0·2	0·1
Tanganyika	53·1	17·4	16·7	7·3	2·7	1·3	0·9	0·2	0·3	0·1
Uganda	52·2	19·5	16·7	7·7	2·9	0·5	0·2	..	0·2	0·1

Distribution of Women 45 Years and Over by Number of Live Births

Territory	*Number of live births (percentage)*									
	0	1	2	3	4	5	6	7	8	9 *and over*
Kenya	36·6	16·2	19·6	12·3	7·1	3·2	2·4	0·6	0·6	1·4
Tanganyika	50·7	12·5	15·0	8·2	4·5	3·0	2·0	2·0	0·6	1·5

African fertility.—With very few figures available in past records to give assistance, any reliable calculation on the trend of African population is difficult to make. From a 10 per cent. sample, statistics of fertility were obtained and these are being analysed fully at the present time. Calculations cannot be based on past estimates, and the census information is not sufficient to permit definite calculations to be formed. Therefore more data must be collected. The statistics that I am providing here are based on two major areas of the mainland of East Africa and the total results for the Protectorate of Zanzibar with information for the two islands given separately. More illuminating studies will be possible when all areas have been analysed. The kingdom of Buganda covers an area of 173,000 square miles, with a population of some 1,300,000 Africans. A registration system of births and deaths has been in existence since 1904 but unfortunately the

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TABLE 5(*a*)

Indian Population

Total Live Births per Woman and Infantile Mortality Rates by Territory and Age Group*

Age group in years	*Kenya*		*Tanganyika Territory*		*Uganda*	
	Live births per woman	*Infantile mortality rate**	*Live births per woman*	*Infantile mortality rate**	*Live births per woman*	*Infantile mortality rate**
15–19	0·3	92	0·2	65	0·2	96
20–24	1·5	69	1·3	71	1·5	63
25–29	3·0	69	3·1	84	3·3	76
30–34	4·4	75	4·5	84	4·7	81
35–39	5·5	84	5·4	88	5·9	101
40–44	6·0	88	6·0	92	6·4	84
45–49	5·8	83	5·8	104	5·9	113
50–54	4·8	87	5·2	102	5·4	129
55–59	4·5	62	4·5	104	4·4	82
60–64	3·7	57	4·3	97	4·6	57
65–69	3·4	60	4·2	108	4·2	88
70–74	2·9	84	4·0	100	4·1	73
75–79	3·4	39	4·5	101	2·3	..
80 and over	2·8	82	3·3	..	2·5	23

NOTE.—For Uganda these rates are calculated from the experience of a very small number of women.

* For definition see Table 4(*a*).

TABLE 5(*b*)

Indian Population

Distribution of Women 15–44 Years by Number of Live Births

Territory	*Number of live births (percentage)*									
	0	1	2	3	4	5	6	7	8	9 *and over*
Kenya	29·7	12·3	12·1	10·5	8·8	7·8	6·3	4·4	3·2	4·9
Tanganyika	33·8	10·9	10·6	9·1	8·5	7·7	5·8	4·7	3·5	5·4
Uganda	26·8	11·7	12·0	10·3	10·0	8·6	6·8	5·1	3·5	5·2

Distribution of Women 45 Years and Over by Number of Live Births

Territory	*Number of live births (percentage)*									
	0	1	2	3	4	5	6	7	8	9 *and over*
Kenya	22·7	5·9	5·7	6·7	9·0	7·3	9·0	8·6	7·6	17·5
Tanganyika	18·8	6·9	6·9	7·2	6·8	9·3	7·5	9·0	7·6	20·0

statistics are not complete. It has been stated that the fertility of the population of this area is not high and the statistics which have resulted from the sample census justify this statement. From the experience of some 26,000 women estimated to be between 16 and 45 years, the average number of live births reported was 2·1 per woman. For those over 45 years, the figure reported was 3·7 per woman. The sample of women over 45 years would be biased if mothers of large families should have a higher mortality rate. Also it is possible that women of this age group are forgetful of those children born long ago. At present, infantile mortality in this area would seem to be from 160 to 200 per thousand live births, if allowance is made for recent improvements in medical services. This is borne out by the figures recorded for women 16–45 years, which were much lower than those for women over 45 years of age. A study of the mortality of live births showed that 47 per cent. of children born to mothers over 45 years of age had died by 1948 and 34 per cent. of children born to younger mothers. Further studies will throw light on any

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differences by districts. It is unfortunate that a better age grouping cannot be calculated but attempts are being made to obtain an age group curve for use in this work. From the number of children reported as under one year at the time of the census, it has been possible to estimate a birth rate with a maximum of 37 per thousand of the population. Some of the children classified in the group "under 1 year" should have been included in the next age group, otherwise it would be difficult to account for the sudden drop from the 45,000 in the group "under 1 year" to an average of about 30,000 in the age group 1 to 5 years. Unfortunately, information on deaths was relatively inaccurate and therefore it has been necessary to estimate the death rate on the basis of infantile mortality. This rate has been taken to be 3½ times the infantile death rate and gives a figure of about 24 per thousand of the population. The natural increase could therefore be around 1·3 per cent. per annum. Although it is impossible to estimate accurately a gross and net reproductive rate with the information at present analysed, researches have produced a gross fertility figure of 4 and a net reproductive rate from 1·1 to 1·3.

In the Central Province of Kenya, an area of 34,000 square miles with a population of 2,000,000, a fairly high rate of fertility appears reasonable. For women over 45, the average number of live births reported was 4·6 with only 9 per cent. childless. The infantile mortality reported was very low, being only in the order of 130 per thousand live births for those women in the group 14 to 45. These figures are being studied in conjunction with other adjacent areas for reliability. The average number of live births per woman in the group 14–45 years was 3 and only 21 per cent. were childless. From these statistics, and a study of the percentage of women by the number of live births, a gross fertility rate of over 5 has been calculated. Once again it is difficult to estimate birth and death rates, but a natural increase of about 1·5 per cent. with a birth rate of about 45 per thousand, would seem reasonable. Of children born, mortality had been 37 per cent. where women were over 45, and 25 per cent. where women were 14–45 years. These are lower rates than were found in Buganda. The statistics would therefore suggest that a natural increase of about 1·5 per cent. per annum with a net reproductive rate from 1·3 to 1·6 is the present population trend in the Central Province of Kenya.

The statistics for Zanzibar cover the total adult female population and an analysis has been made by the two islands. The fertility patterns of the two islands are different, and more calculations can be made as the population has been analysed by 5-year age groups. Table 6 sets out the average number of live births to women in the various age groups. The fertility pattern of the Island of Zanzibar showed that average live births per woman of the age groups 15–44 numbered 1·9 with a steeply increasing fertility curve to the age of 34. The average live births per woman

TABLE 6

African Population: Zanzibar Protectorate
Total Live Births per Woman by Age Group

Age group in years	*Zanzibar Island*	*Pemba Island*
15–19	0·9	1·1
20–24	1·7	2·3
25–29	2·0	3·0
30–34	2·4	3·7
35–39	2·4	3·9
40–44	2·5	3·9
45–49	2·5	3·8
50–54	2·4	3·9
55–59	2·2	3·6
60–64	2·3	3·7
65–69	2·0	3·4
70–74	2·1	3·7
75–79	1·7	3·1
80 and over	2·1	3·7

45 and over was 2·3. Infantile mortality appears to be in the order of 140 per thousand live births and the birth rate calculations give a figure of 15 per thousand of the population. A death rate is difficult to estimate, but taken at four time. the infantile mortality rate the natural increase

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would be small. I have estimated that gross fertility is 2½–3, and, with the present estimated death rates, the net reproduction rate may be under 1. In the case of Pemba Island the average number of live births per woman 15–44 was 2·9, and 3·7 per woman for those 45 and over, with the same fertility curve as tabulated for Zanzibar. A higher infantile mortality, some 200 per thousand live births, was estimated from the statistics though the rate may have declined in the last few years. The calculated birth rate is higher than in Zanzibar, being of the order of 30 per thousand of the population while the death rate would be about 50 per cent. above the Zanzibar figure.

A gross fertility of about 4 with a net reproductive rate from 1·1–1·3 has been estimated from these statistics. For the Protectorate as a whole the calculation of the natural increase provides a rate of less than 1 per cent. per annum. The absolute increase in population from 1931 to 1948 was about 14,000.

The main statistics of number of children born, averages and infantile mortality rates in the four areas are given in Table 7.

TABLE 7(*a*)

African Population

*Total Live Births per Woman and Infantile Mortality Rates**

Territory	*Age Group: To 45 years*		*Age Group: Over 45 years*	
	Live births	*Infant mortality rate**	*Live births*	*Infant mortality rate**
1. Central Province (Kenya) . .	3·0	130	4·6	146
2. Buganda Province (Uganda) . .	2·1	203	3·7	239
3. Zanzibar Island*	1·9	157	2·3	145
4. Pemba Island*	2·9	214	3·7	209

* For definition see Table 4(*a*).

TABLE 7(*b*)

African Population

Distribution of Women to 45 Years by Number of Live Births (Percentage)

Territory	*Number of live births*									
	0	1	2	3	4	5	6	7	8	*9 and over*
1. Central Province (Kenya)	21·1	14·3	13·8	12·5	11·3	9·4	7·1	4·8	2·8	2·9
2. Buganda Province (Uganda)	36·4	18·2	13·4	9·6	6·8	5·1	3·7	2·4	1·6	2·8
3. Zanzibar Island* . .	33·8	19·9	15·0	10·2	6·7	4·8	3·1	2·4	1·5	2·6
4. Pemba Island* . .	22·9	15·6	14·5	11·5	9·2	7·2	5·8	4·2	2·8	6·3

Distribution of Women Over 45 Years by Number of Live Births (Percentage)

Territory	*Number of live births*									
	0	1	2	3	4	5	6	7	8	*9 and over*
1. Central Province (Kenya)	8·8	5·4	8·6	12·1	14·8	14·4	12·1	8·8	6·6	8·4
2. Buganda Province (Uganda)	24·4	10·7	11·4	10·2	9·4	7·8	6·9	5·1	3·6	10·5
3. Zanzibar Island* . .	38·3	16·3	11·8	7·7	5·7	4·4	3·9	3·0	2·5	6·4
4. Pemba Island* . .	25·1	13·2	10·0	7·1	6·0	6·3	6·2	5·2	4·6	16·3

* For these areas, the division has been made at 44 years.

Conclusions.—Research is continuing as more information becomes available from the sample census, and studies by areas are proceeding. The estimates provided here are the first which have become available from the census and the conclusions cannot be considered as anything but

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tentative. The East African Statistical Department has at present obtained certain information on fertility but a great deal more must be obtained in the future, especially on current birth and death rates. This information should be obtained by means of sample surveys rather than by a system of registration.

The statistics, as provided, show a general pattern and can, I believe, be used to prove that estimates of total population growth for African territories are highly dangerous and that fertility in the various areas differs greatly. It would appear that a high rate of increase is not yet in existence in the East African territories, and that in certain areas the rate is low. To try to make the present tabulations prove anything more accurate would be most dangerous.

LORD HAILEY said that he must approach this question, not as one versed in the technique of the statistician, but from the view of one who had spent his life in administration or as a student of administrative policies.

In view of what Mr. Searle had said, he himself recalled the period in the years 1936 and 1937 (which was about the time that Sir Gerard Clauson had written his paper on Colonial Statistics) when he was engaged in preparing his own Survey of the problems of Africa. He had included a chapter dealing with the statistical material available, and been obliged to point out its many deficiencies. Even such slender statistics as were available in most Colonies had been compiled by each Colonial government on a different basis, and there was a clear lack of any central guidance such as that which had been provided by the Central government in India to its different Local Governments and their operative departments.

There were, of course, well-established statistical offices in Southern Rhodesia and the Union of South Africa; but these owed their origin to the need of supplying information to active Legislatures and an interested and inquiring public, both of which were lacking in most of the British Colonies of the period.

Since then there had been much improvement in the position in the Colonies, not the least of which had been the creation of a Statistical Department in the Colonial Office itself, largely as the result of advice rendered by the Colonial Economic Committee. A beginning had also been made in the creation of a statistical establishment in the Colonies, and he was strongly in favour of Mr. Searle's suggestion for the establishment of a central "pool" of statistical officers, for which a precedent existed in the "pool" of Geological, Survey and similar specialists created under the advice of the Colonial Research Committee. It would be some years before the new Colonial Universities in the West Indies and West and East Africa would be able to supply recruits for local statistical services, and they would in any case need a period of training at Home.

There was, however, another important consideration. Adequate statistical material was essential to the administrator, the politician and the statesman. But the statistician was himself dependent on the material supplied to him either by Departments of the Government or by the various agencies carrying on commercial, industrial or social activities. The statistician could help to guide their form; but his chief concern now must be to endeavour to make the Governments and the public more statistically minded. It was hardly necessary for him (Lord Hailey) to enlarge on the extent of the field in respect of which it was necessary to stir the Governments to activity. As Mr. Martin had said, considerable interest has lately been shown by them in the matter of the census of population, and if anyone wished for an illustration of the haphazard guesses on population figures which had been accepted in the past, he would refer him to the chapter on the subject in his *African Survey*. But crude census figures were an insufficient guide for ascertaining population trends; one needed far more attention to the preparation of vital statistics and to the record of the movements of the native population, such as those taking place, for example, between Portuguese East Africa and Nyasaland, or Ruanda-Urundi and Uganda, or from the French territories into the Gambia and Nigeria.

Agricultural statistics formed another illustration. With the example of India before him, he could not fail to be struck by the comparative absence in the Colonies of any basis for the collection of statistics on agricultural production, save, of course, that relatively small proportion which is reflected in export figures. Until the Governments were aware of the need of cadastral or topographical surveys as the basis for the compilation of statistics of production, they had to rely on guesswork, or the results of experiments by Agricultural Departments, which were very fallacious as a basis for calculating the out-turn of a District, or still more of a whole territory.

In Animal Husbandry the only guide to the number of stock (save in the few areas where there was a cattle tax) was the figure of inoculation against disease; but sheep anyhow did not get inoculated. In other fields the figures were very unreliable as, for instance, in education those of literacy. In Nyasaland, the Government and the Missions used to take credit for the fact that

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over 40 per cent. of the adult population was literate, but a recent census, using a different standard, cut this down ruthlessly to about 7 per cent.

He would not multiply these illustrations, for it might seem that he was discrediting the considerable improvement which he had himself admitted. He would only repeat his point, that it was one of the functions of the new statistical service to endeavour to make the Governments and the public more statistically minded, and he hoped that they would use any influence they could command to this end.

Mr. SHAUL said that Lord Hailey had very rightly drawn attention to a serious deficiency in many of the statistics in what was very popularly termed the Dark Continent. The statisticians who were engaged in trying to fill this deficiency were acutely aware of the importance and the nature of the work required. He would like to bring to the notice of the Fellows of the Society some work which had been done in Africa in the endeavour to fill these gaps. It was an application of the very revolutionary work which was being done by eminent Fellows of the Society, amongst whom he would mention Professor Fisher, Dr. Yates, Professor Mahalanobis and others of international repute such as Dr. Deming, Professor Darmois, etc. Modern sampling methods provided a flexible means of sampling in areas where complete enumerations were, from the very nature of things, impossible.

In Africa the only way of approaching the problems of enumerating these groupings—or almost the only way of improving the statistics of the vast African population—was afforded by some method of scientific sampling. Like all good instruments sampling could be used well or badly. It must be used intelligently and with great care. In Central Africa they had been aiming at shedding some light on the problems which were exercising Lord Hailey's mind. He would mention one of them—vital statistics. It would obviously be many years before, with populations of this nature, a comprehensive, reliable, and accurate registration of births and deaths could be introduced. The only way to approach the question of getting vital statistics of good quality at an early date was by organizing good and intelligent sampling surveys, and, as Lord Hailey had rightly said, these surveys must not be isolated. They must be so arranged that the trend of the time series could be seen. Isolated figures lost considerably in their value. To establish trends they were attacking the problem in Central Africa by holding demographic surveys of the African population at regular intervals.

In the current year they were engaged on a demographic survey in Northern Rhodesia; another such had been undertaken in Southern Rhodesia in an earlier year. They did not propose to stop at one survey, because it was realized that the results of such surveys were of little value without a knowledge of trends and time series. In each of the Central African territories, Southern and Northern Rhodesia, it was hoped to have in course of time a knowledge of the general movements of vital statistics based on triennial surveys.

In 1949 sampling agricultural surveys were carried out in Southern Rhodesia, in which the minimum programme was that set by the Food and Agricultural Organization of the United Nations for undeveloped areas in connection with the World Agricultural Census. They did not intend to stop there, and this year they were carrying out experimental field surveys in Northern Rhodesia to see to what extent something of the same nature could be organized in that country. At the back of their minds was the very important question which Fellows of the Society would appreciate, concerning the rate at which the African populations were growing and the extent to which their food resources could keep pace with their growth. Until they had accurate scientifically conducted inquiries into the food resources, the acreage under cultivation, and the rate of growth of the population, they could not appreciate the full bearings of this problem in its national and international implications. For that reason they were most anxious to get the statistics of food production and the demographic statistics of these populations in Central Africa on a firm scientific basis. From the demographic sample considerable information would be obtained which would enable sampling services in agriculture to be improved.

With regard to their agricultural census in Southern Rhodesia, as a result of the sample they were now in a position to divide the country into natural regions based on character of soil, amount of rainfall, altitude, and so on, and to determine the significance of different forms of cultivation. They were making research into the possibility of getting annual output figures, and were experimenting on a scheme for Southern Rhodesia at least which would, it was hoped, lead to crop forecasting. Fellows of the Society would realize the significance of such a programme. Much research would have to be done. They were by no means indifferent to the very serious problem confronting them in Africa, and they were actively making experiments towards the improvement of statistics by the application of the most recent scientific advances in statistical technique..

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Mr. E. HALLETT said that the first speakers were producers of statistics; the distributors he supposed would be the printers; and he was one of the consumers. The meeting might like to know what a consumer thought was important. He was interested in the West African trade, and what he had to say would have relation to that trade and not to any other use to which statistics might be put. His first point was that he felt that there was a complete lack of balance on the question of agricultural statistics. The British West African Colonies and most of the others were predominantly agricultural. The whole economy of these countries depended upon agriculture in one form or another, and next to nothing was known about the size of the local production of foodstuffs, even of such commodities as entered the export market but were partly consumed locally. The tonnage of groundnuts exported from Northern Nigeria was well known, but no one had the least idea how much was used locally; the same remarks applied to palm-oil in the south; the export figure was known, but no one knew how much was used by the African.

To give an idea of how interesting an investigation into that could be: he had found that some Africans in South-eastern Nigeria consumed over 100 lb. of palm-oil in the course of a year—double the amount recommended by the Hot Springs Conference of 1944. He did not say that the whole of South-eastern Nigeria consumed palm-oil on those lines, but it showed that there was room for an investigation. To dismiss the question of local food production as a matter for sociological survey or small samples was to give a wrong emphasis to the whole problem. It might be said that comprehensive figures of that kind could not be obtained, but in reply he would point to Egypt, where a system was put into force by the British many years ago whereby they had very accurate estimates of the amount of locally produced foods and the cotton crop. The whole thing was done by central organization through the Ministry of Agriculture.

One of the speakers had referred to a visual survey of crops for the purpose of obtaining crop estimation. That was largely the way it was done in Egypt. The results were extremely accurate, and he would recommend the method to the Colonial statisticians.

His second point was with regard to the balance of payments. It might be thought that a trading company would have no interest in the balance of payments in West Africa, but it had a very great interest indeed. For its own purposes such a company prepared internal spending power estimates. He had no particular regard for estimates of national income, which he looked upon as an intellectually delightful fiction. The sectionalization of prices in primitive countries was sufficient to rule out any use that a national income figure could be put to, more particularly in a dynamic economy. His Company would like to have balance of payments statistics in order to marry up with their internal spending power figures. These latter figures were used rather as prophecies on which to found budgets for the needs of a particular Colony. The Company would like to make a *post facto* check of these figures (even if it were two years after the event) by comparison with the official figures. Thus, for the business communities it would be very important if good balance of payment figures could be produced.

His third point, the question of educational statistics, had already been referred to by Lord Hailey. The Colonial Governments in West Africa were recently asked to give figures of the degree of literacy, and only one of the four British West African Colonies was able to give such an estimate. It might be thought that a trading company had no reason to ask for statistics of literacy, but such figures were useful both to the Colonial Governments and to business firms. It would be as well for Colonial Governments, even if only for political reasons, to know the size of the student population. Everyone knew what a surplus of students could do to the politics of a country! The trading companies wanted to know the size of the field out of which they could obtain their working staff, and to what extent they were likely to have to compete with other firms, with the Government, and with politics.

His fourth point was that the business man would find a great use for a regular annual statistical abstract. He thought it did exist in one or two Colonies, but it certainly did not in British West Africa. It would be of great practical use for a business man to be able to consult one book which would give him a series of the more important figures going back for a number of years.

His fifth point was in practice the most important, and that was the need for promptitude and regularity. He knew that this shortcoming had already been mentioned, but he would like to emphasize it. For instance, for some Colonies the 1948 figures were just arriving, fifteen months out of date. They were interesting as historical documents but were of very little use in business. This had been countered by the suggestion that firms could ask for whatever figures they required *ad hoc*. "Ad hoc" he wanted all the figures. He would give an instance of what could happen. The West African Currency Board Report for 1948 was published a few months ago and the Report for 1949 a fortnight later. He had asked for the earlier figures a week or two before they were to be published, and he was told that he could not have them until they were published, which, of course, was not of very much use.

The bottleneck was evidently the printing press; and if the bottleneck were so difficult he

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would suggest that a year's statistics should be missed out altogether and two years published together, thus catching up a year. Perhaps this would not be regarded as a very desirable practical method, but he put forward the suggestion for what it was worth.

His last point was with regard to cost-of-living indices. It was usual to publish a cost-of-living index for the capital town of a territory, which meant very little. In Nigeria alone one could do with at least five different indices from five different points in the territory. To suggest that the cost-of-living index in Lagos was an indication of what the workers in Kano should be paid was ridiculous. The index for different strata of the population would also be of untold value. It might be said that this was not possible or that it was very rarely done; but the Shell Company had an excellent index of this kind in one of the territories with which they dealt, and they found it of great value in their own business. If the Colonial statisticians could produce something of that kind it would be very useful to the business community.

Mr. A. MORAIS said that, on the whole, the development of national income studies throughout the world had been a recent one. Some time passed, however, before non-self-governing territories of the British Empire became acquainted with the mechanics of the new study, and its practical application to the diagnosis of social and economic problems.

As far as Jamaica was concerned, its first real acquaintance was associated with the arrival in the island in 1943 of Dr. Frederic Benham with the assignment to undertake, under the aegis of the Colonial Development and Welfare Commission, the preparation of estimates of the national income of British West Indian territories.

The field difficulties he encountered were numerous and varied, partly owing to the disinclination of many responsible private agencies to be helpful by making useful data available, and partly to the early stage reached in the development of official statistics. Five years earlier, on the occasion of the visit of the Royal Commission to inquire into the social and economic problems of the Colony arising out of the labour disturbances of 1938, the Commission felt forced to comment on the shortage of reliable statistics in any field which could provide a useful basis for the elementary analysis of local problems or even on which to frame general opinions. Apart from the normal public accounts of revenue and expenditure of assets and liabilities and of external trades, little remained that was of sufficiently sound statistical character to be a basis for reliable analysis and appraisal.

Between 1938 and 1943, however, considerable improvements had taken place in many fields. The Labour Department was established consequent on an island-wide unemployment survey conducted in 1938. With this, the only available form of statistical data appertaining to labour, the administration set up its first Labour Statistics Branch. At once its activities grew. Between 1939 and 1942, the year to which Dr. Benham's first estimates of Jamaica's national income related, the Branch had conducted, *inter alia*, a cost-of-living inquiry among working-class persons, computed a cost-of-living index, developed annual wage rates reviews, compiled statistics of employment in major industrial undertakings and public works and unemployment relief.

The beginning of hostilities in 1939 provided the first great impetus to national accounting. The country went to its books. Stocks of consumers' goods were assessed and frozen. Further imports were largely controlled by licences and distributed by quotas; exports were almost exclusively handled in the first stage by official agencies. Transportation and communication came under the Government's control. Stocks of fuel of all kinds, heavy durable replacements of plant and equipment were rationed. The respective competent authorities built up invaluable records of retail prices, distributors' margins and transport charges as bases on which to compute fixed maximum prices of consumer goods and services released to the trade. Internal bulk purchasing of local commercial crops provided useful data on total output, and early statistics on the marketing of these commodities were framed by the newly established Marketing Department. Most important of all and as an added fillip to the "new learning" a complete territorial census of population, housing and agricultural, was completed between the years 1942–44.

Benham devoted considerable space to the assessment of the value of production, as that was the approach for which most material was available and on which most reliance could be placed. Fully admitting the advantages to be gained by the use of the "factor cost" method in addition to market prices, he used the "short cut" system of eliminating "value added" components and estimating only for total volume of production and gross values thereof. The stage reached in the development of the relevant statistical series at the time precluded the adoption of any other course unless a very wide margin of error were tolerable. This was considered unwise, having regard to the fact that these estimates were later to form the basis for future assessments.

In 1945 the Central Bureau of Statistics was established. The work of building upon the recent census mosaic was started in addition to the development of many of the standard series.

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The Department was a merger of the statistical sections of the Collector-General's Department (External Trade Statistics), the Labour Department (Statistics Branch) and the residual Census staff, thereby pooling the original framework and material of past surveys as well as current studies.

A harmonious liaison was established between other Departments collecting relevant data, and with those aids the Bureau completed its first national income assessment in respect to the year 1943, now the second in the series. Done on a "factor cost" basis it compared somewhat with the model framework designed by Miss Phyllis Deane, who had since prepared estimates for Jamaica for ten pre-war years.

The degree of reliability of the present estimates was open to improvement, and practical efforts were being made to this end. In 1948 a census of manufactures was undertaken in respect to the year 1946, and a factual basis, though limited in scope, now existed for assessing the progressive value of secondary production. Censuses of transport, construction and merchandizing were contemplated as part of this and next year's programme, in addition to a sample census of primary production now being conducted. As the coverage expands, greater reliability, refinement and representativeness would be assured.

That was most desirable in every respect, evaluating as it did the net value in terms of money of the total economic effort of a territory over a given time, or tracing the flow of money incomes to the national factors of production, or finally checking the channels through which incomes were disposed of by their recipients. National income assessments remained to-day the best single measure of the economic position of a territory, and provided the necessary allowances were made for variations in price levels they proved a fairly reliable general index of economic progress through time, and were even bases for assessing comparability in the economic structure between territories.

Mr. W. G. Wormal said that Lord Hailey had referred to the great need for the Colonia Governments to become statistically minded, and he thought that every Government statistician appreciated very much what he had said. Statisticians had a duty in this direction themselves, and he would like to invite attention to what they might do in their internal work, within their Colonies, quite apart from what they did in respect of services for the rest of the world. The Colonial Government statistician's work was of a dual nature. He had a minimum body of information to prepare for general consumption, but he was also called upon from time to time, usually at extremely short notice, to produce evidence for the formulation of policy. In no field of statistical activity had this been more difficult than in connection with calculations relating to the cost of living. It was essential to present the results of such calculations in such a manner that they were not only sound and good reading for statisticians, but were also intelligible to the layman.

It was also important in connection with cost-of-living inquiries that the statistician should resist any attempt, by parties interested in the construction of theoretical or type budgets, to suggest what the expenditure of a household should be rather than to find out the facts of actual expenditure. The statistician must base such calculations on objective evidence, and not on theory or opinion; and this was not always easy to explain to interested persons.

Another direction in which these calculations were liable to be affected was through the limitation of expenditure. Often the sample was reduced to small dimensions on grounds of economy, whereby the wide use of investigators was precluded. The biggest problem, however, remained in the presentation of the results. A purely statistical report setting out the results of an inquiry in technical language was not good enough. It was not possible to secure public acceptance of the results of the inquiries if the results were presented in an indigestible form. This was a particular difficulty with which the statisticians of Colonial Governments were faced. They were in this respect the public relations officers of their Governments. It was their duty to produce reports on this and other subjects intelligible to the people; otherwise their value was greatly diminished. This was a problem which time would not resolve; it was a permanent one.

Colonial Government statisticians, however, were sustained in their efforts by the knowledge that they were part of an international brotherhood of people who were intent on the discovery and measurement of fact. A concrete example of the success of this international co-operation was the *Bulletin of the Statistical Office of the United Nations*, and the advice and help that that Office was always ready to give to statisticians. Colonial statisticians were glad to acknowledge their debt to the Statistical Office. And now that a Department of Statistics had been established at the Colonial Office they were provided with even closer links with one another, and a central driving power.

The present meeting was held at a very interesting juncture. Hitherto Colonial Government

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statisticians had been working in rather an unco-ordinated manner. Now they were starting to go forward together, and their way would be made easier and straighter by the pooling of experience and by better opportunities for concerted action.

Mr. STUART WILLIAMS said that he represented Nigeria, and he thought it would be worth while to consider some of the differences between collecting statistics in Nigeria and in the United Kingdom. The position in the United Kingdom was extremely well known, but the Nigerian position was a very difficult one indeed; they were on the threshold of statistical work, and there was an enormous amount to be done.

The cost-of-living index had been mentioned, and in that respect he would say that in Nigeria there were no marked prices for goods; the price paid was the result of a bargain. There was bartering in the markets for the goods purchased, and investigators had to try to discover the actual buying price. Again, when trying to determine rent there were difficult problems, particularly in places like Lagos, where a room might contain as many as twenty people. They might all live and sleep there or some might live there and sleep out. How was the rent to be apportioned under such conditions?

These were obstacles which had to be overcome. The population statistics were crude, but endeavours were being made to get a reasonably sound population census. Agricultural statistics virtually did not exist, purchases for export were known, but nothing was known about the subsistence crops, which formed a very great part of the agriculture.

These were some of the simpler problems; more difficult ones were associated with two very big factors—suspicion and superstition. Suspicion arose from the fact that there was a head tax, and wherever there was a head tax in existence people would try to hide the fact that they were alive; when there was a cattle tax they tried to hide the cattle. The people automatically assumed that any attempt to get statistics was for the purpose of taxation.

The point of superstition affected population statistics. There was a curious superstition among some of the tribes in Africa that the name of the oldest boy should never be disclosed, and that in fact he did not exist beyond the family. He thought these obstacles had been overcome recently in the census of Lagos, but he could not be certain until the results had been analysed.

Mr. J. H. WEST referred to two points in the paper, which he thought was the most interesting account of Colonial statistics he had seen. He asked if it would be possible for Mr. Searle to explain, when the paper was published in the *Journal*, to which departments in the colonies the various statistical offices were responsible. Did they, for instance, have access to the Governor, or were they sections of the Economic Staff? It had always seemed to him that the success of a statistical office very largely depended on the amount of support received from higher authority, and although the co-ordinating influence of the Colonial Office in London was of great importance, the local status of each office in relation to the rest of the administration was probably the critical factor in deciding its sphere of influence.

The second point which had interested him was the table, presented almost apologetically by Mr. Searle, which showed that senior statisticians represented something like 4 to 8 per cent. of the total administrative staff of the Colonies. He commented that if the same high ratio applied in England, home statisticians would be more than satisfied.

Mr. W. F. SEARLE subsequently replied in writing as follows:

As there were few specific points on the contributions to the discussion made by Mr. Phillips and Mr. Martin, I am undertaking a general reply. My task is easier than it might have been because the Colonial Government Statisticians who have spoken have taken up a number of points made by the consumers of Colonial statistics which might otherwise have fallen to me to answer.

I am very glad that the need for better agricultural statistics was stressed by both Lord Hailey and Mr. Hallett. I did not hesitate to bring out the inadequacies of the present statistics in section II of my opening remarks and I am sure that all the Colonial Government Statisticians are in complete agreement on the priority which ought to be given to overcoming these deficiencies. My own views are in line with Mr. Shaul's who, I think, brought out well the way progress can be achieved. Mr. Hallett, however, seems to have doubts—he referred to the wrong emphasis given by small samples and then commended the comprehensive Egyptian figures. Complete surveys, even if the data recorded are approximate visual estimates, are not practicable in Africa and in other undeveloped territories. Even small samples, properly analysed, give answers which may be useful, providing the margin of uncertainty is appreciated. As agricultural statistics develop in Colonial territories I hope it will be possible to have samples large enough to enable

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year to year changes to be measured with a fair degree of precision in each of the significant regions of a territory. The aim, as I see it, lies between Mr. Hallett's small samples and his comprehensive figures.

Lord Hailey mentioned the difficulty of defining literacy in census questionnaires and he might have gone on to the related problem of the varying interpretation which census officials give to whatever question is framed by the census organizers. The recommendations of the United Nations Population Commission are likely to result in a narrower range of definitions in the future but, even so, international comparisons are always likely to be made rather uncertain by varying interpretations of the recommended definitions. The related problem of educational standards, which was raised by Mr. Hallett, will be solved to some extent by the new educational statistics to which I referred in my opening remarks.

Mr. Hallett has all our sympathies when he refers to the existing delays in the publication of trade returns and other statistics. Printing delays are a very important factor and they have an insidious secondary effect. Knowing that there will be printing delays, the staff engaged on preparing statistics for publication take longer over their work than they would if they knew that printing would be speedy. Mr. Phillips has mentioned the photo-litho method of reproduction as an alternative to printing and I think this may be a solution for such documents as monthly trade returns. Perhaps a little competition would speed up the printing of other statistical material.

Nobody, I think, would dispute Mr. Hallett's view that several cost-of-living indices should be calculated for a territory like Nigeria. I am more concerned about the people who overstate the case and argue that scores, if not hundreds, of index numbers are required. It should not be beyond the scope of a reasonably well-established Statistics Department in Nigeria to calculate five or so separate index numbers and I imagine they will do so once a satisfactory "Lagos" index number has been created.

The reply to the question asked by Mr. West is that most statistics departments in the Colonial territories are separate departments such as Commerce and Industries, Customs and Excise or Education. As such, they are linked with the Secretariat and the Colonial Government Statisticians have contacts with the Secretariat at various levels. On matters of great importance they may have direct contact with the Governor. To some extent the level of contact depends on the reputation which the statistician has built up. There are a few exceptions to this form of organization, e.g. in the Gold Coast the Statistics "department" is a section of Secretariat itself.

Mr. West's second point emphasizes that the relationship set out in my Table 2 is not a simple one and that I have not enough examples to carry out a thorough analysis. Clearly a country like the United Kingdom is not "within the range of type and size of territories we are considering"; the ramifications of official activity increase the number of the central administrative staff without a corresponding need for statistical services. Even within the range under consideration the relationship may be over simplified by the assumptions I have made. I must also warn Mr. West that he has spoken of total administrative staff whereas my definition of "central administrative staff" excludes a number of administrative officers. Furthermore, there is no counterpart in undeveloped territories of the work on overseas affairs and defence which absorbs administrative officers, but few statisticians, in countries like the United Kingdom.

I can speak for all those connected with the development of statistics in Colonial territories when I say that we have found tonight's discussion useful and stimulating. When the next account of Colonial statistics is published, there will be further advances to put on record, but, as our resources are limited, there will still be many fields which good farmers will regard as under-cultivated.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Mohamed M. Agamieh.
Charles Philip Cox.
John Thomas Duff.
Dennis Charles Fakley.
Anil Kumar Gayen.
Basil Geoghegan.
Leslie Lister Hall.
Stanley Noel Higgins.
Derek Edward Hill-Smith.
Roger Deyo Keeney.
Abdul Qayyum Khan.
Tobias Lewis.
Geoffrey Charles Naylor.
Alexander Burt Ross.
Deoki Nandan Saxena.
Robert Thomson Smith.
James Leslie Stewart.
Leslie Stanton Sutton.
Alan Frederick Tout.
John Wilder Tukey.

Corporate Representative

Lawrence Eversley Campbell, *representing* the British Food Manufacturing Industries Research Association.

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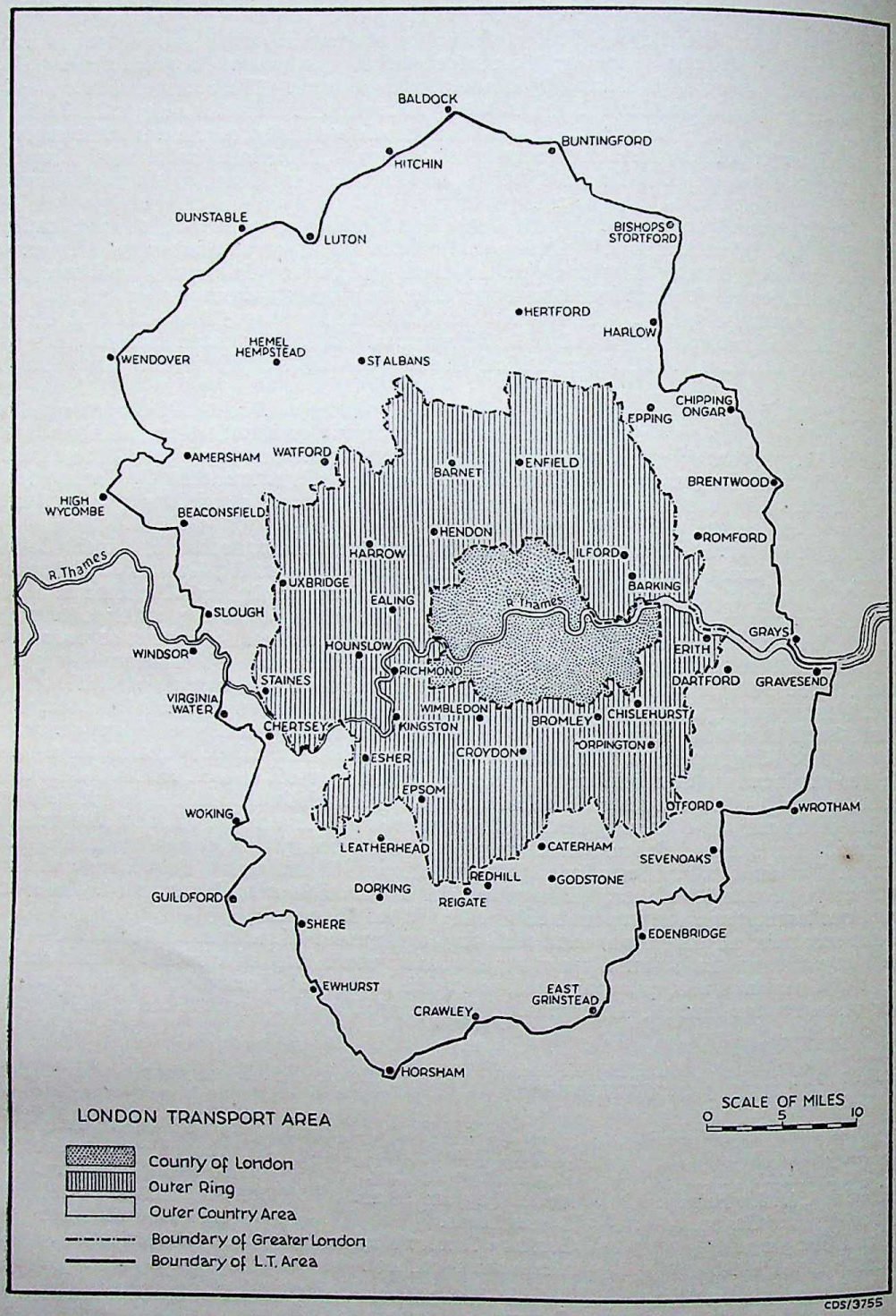

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LONDON AND ITS PASSENGER TRANSPORT SYSTEM

By F. A. A. MENZLER, C.B.E.

[Read before the ROYAL STATISTICAL SOCIETY, April 26th, 1950, the PRESIDENT, SIR GEOFFREY HEYWORTH, in the Chair.]

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I. INTRODUCTION

1. IT is nearly fifty years since Sir (then Mr.) Edgar Harper submitted to this Society his paper entitled "Statistics of London Traffic" (*J. R. Statist. Soc.*, **67**, 177). The material for that interesting and thorough study was also employed in the evidence he submitted to the Royal Commission on London Traffic, which was then sitting. A perusal of the paper serves as a reminder of the obstacles that had in those days to be overcome when it was sought to gain a global view of an essential service provided by a congeries of separate undertakings, mainly under the auspices of private enterprise. There was, of course, no obligation upon anybody to render to the public a coherent account of the services provided by the numerous independent agencies, supported by the consistent numerical data to which we have become accustomed in reports on the activities of public administration. Thus, Sir Edgar Harper had to assemble figures relating to twenty-eight separate railway undertakings, including joint lines, in order to give a complete account of the railway services of Greater London. Even then he was not in a position to distinguish adequately between passenger traffic local to the area and that from distant provincial centres, which cannot properly be regarded as falling in the category of "London Traffic". Whatever may be the case for public ownership of an industry or service, it has one merit to statisticians: it affords at least the possibility of obtaining, generally for the first time, an overall conspectus of the activity in question.

2. Since Sir Edgar Harper wrote his paper, travel in London has undergone a revolution—indeed, several revolutions. The first phase was associated with the rise of the Underground Group of Companies under the leadership of Lord Ashfield and Mr. Frank Pick, both, unhappily, no longer with us. This was the period of active tube development, and the replacement of the horse tram by the electric tram and of the horse bus by the petrol bus. The horse tram did not disappear until 1915, and the horse bus not until a year later, although the London General Omnibus Company ran no horse buses after 1911.

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3. The formation of the Underground Group represented the first major step towards the ultimate goal of complete integration of London's local passenger services. By means of financial control, effected through the agency of a holding company known as the Underground Electric Railways Company of London, administrative unification had been achieved before World War I of the services provided by the surface and sub-surface Metropolitan District Railway, the deep-level tube railways, and the London General Omnibus Company. It was mainly after World War I that the "Underground" interests were extended to the privately-owned tramways and to bus services in the outer areas. The "Underground" also had pooling arrangements with the Tilling undertakings whereby nearly 300 buses owned by those companies were operated, chiefly in south-east London, as an integral part of the "London General" fleet. By 1933, rail and road services carrying some 60 per cent. of the passengers in the London area were provided under the direction of the Underground Company. Outside this group of services—rail, bus, tram, trolleybus, and coach—and, it must be emphasized, in competition with it, were the important suburban services of the four main line railway companies and certain joint lines, and of the Metropolitan Railway; the widespread systems of tram services of the London County Council and other municipalities, particularly in south and east London; and a miscellaneous group of some 130 independent bus and coach operators owning between them roundly 900 vehicles. In this competitive situation, much needed tube development was effectually inhibited. The problem could only be resolved by carrying to completion the process of unification upon which the Underground Group had embarked. It was to achieve this purpose that the London Passenger Transport Board was set up.

4. On or shortly after 1st July, 1933, the London Passenger Transport Board took over the ownership and operation of the whole of the complex of services described above, with the single—but important—exception of the suburban services provided by the four main line companies and the joint lines within the Board's area, referred to subsequently as the London Transport Area. These suburban services then carried one-eighth of all the passengers, road as well as rail, within that area, which extended over nearly 2,000 square miles within an average radius of approximately 25 miles from Charing Cross, and had a population of 9,358,000. This area was materially larger than Greater London, which lies roughly within the 15 miles radius, but which then contained nearly 90 per cent. of the population to be served. The problem of competition with the suburban services of the main line railway companies was solved by means of a statutory body, the Standing Joint Committee of the Board and the Main Line Companies. This committee had the general duty of securing the co-ordination and development of all local services within the London Transport Area. It was also directed to prepare a scheme for the pooling of all passenger receipts arising from traffic local to the Area. In this way planning for the traffic needs of the whole area could proceed without the necessity to have regard to sectional interests, which had previously been so great a handicap to the development of London's tube railway system.

5. For working the financial arrangements embodied in the pooling scheme, it was obviously necessary to separate from the figures of the total services operated and traffics carried by the main line companies those which related to journeys entirely within the London Transport Area. Thus, from 1st July, 1933, there became available for the first time a consistent body of figures, free from arbitrary assumptions, which afforded a continuous and comparable series of statistics of car miles, takings, and passengers, and which gave reliable indices of the standards of service provided and the volume of travel in the London Transport Area as a whole.

6. Nationalization, from 1st January, 1948, of the country's public land transport services did not bring about any major change in the arrangements summarily outlined above. The London Passenger Transport Board became the London Transport Executive, one of six "Executives" under the administrative direction of the British Transport Commission; the finances of London Transport were merged in those of the Commission; and the elaborate pooling scheme became redundant and was brought to an end. The London Transport Executive have continued to operate the same group of services as the Board, but have also taken over certain joint and other lines local to the London Transport Area. The Railway Executive assumed responsibility for the suburban services previously provided by the four main line companies.

It may be added that the London Transport road services consist in the first place of the red Central Buses, which operate within an area of about 17 miles' radius from the centre of London,

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and the Trams and Trolleybuses covering a somewhat smaller area. These are referred to collectively as the Central Road Services. There are also the green Country Buses operating in the outer country regions of the London Transport Area, and the Green Line Coaches running from country towns on one side of London to country towns on the other.

II. The Transport Problem in London Fifty Years Ago

7. Fifty years ago, when the petrol engine was still in its infancy and the replacement of the horse tram by the electric tram was proceeding apace, traffic congestion in London streets and peak hour overcrowding of the public rail and road transport services were already matters for anxiety. The Royal Commission on London Traffic was accordingly set up in 1903, with wide terms of reference. The pessimist in public affairs will doubtless derive a certain melancholy satisfaction from the thought that some of the remedies mentioned in the Commission's report have still not been applied—and are still being recommended—to-day, some fifty years later.

8. The Commissioners urged, in the first place, that the census of the population should be taken by reference to workplace as well as home in order to provide basic data for the better assessment of transport requirements. This was not done until the census of 1921, and the effort was largely wasted, for the analysis was not repeated at the census of 1931, and there has been no census since. To deal with traffic congestion, the Commissioners emphasized the need for wide streets and for a co-ordinated plan of road development. London streets were frequently survivals of village roads and lanes, and their development into metropolitan thoroughfares, under the care of small and independent local authorities, had been haphazard and uncontrolled. By the turn of the century, however, there was talk of urban planning on a broad scale. Suggestions were being made for a ring road to be built at a radius of 12 miles from St. Paul's Cathedral, and for a number of new highways in various classifications, ranging from "Main Avenues" 140 ft. wide from house to house to "4th class streets" 40–50 ft. wide. Foremost among these proposals were the "main West–East Avenue", to run from Bayswater Road to Whitechapel, and the "main North–South Avenue", to link Holloway and the Elephant and Castle, thereby anticipating in principle the proposed cross-routes "X" and "Y" of the County of London Plan. It may be remarked that, although the number of planning authorities in the London region has been reduced to 12, actual physical development in London is still in the hands of over 200 autonomous county, local and other authorities; effective co-ordination is accordingly difficult to achieve. The London Planning Administration Committee, under the chairmanship of the Rt. Hon. Clement Davies, K.C., M.P., only last year recommended the examination of this aspect of the problem by a Royal Commission.

9. The projects of the early 1900's have a familiar ring in 1950, but with one major difference of emphasis for transport. The main West–East and North–South Avenues were to have four lines of tramway on the surface and four lines of railway a few feet below the surface. The electric tramway was indeed regarded, fifty years ago, as a form of transport that was indispensable in a large urban community. The Commissioners referred to a "sanguine expectation" in some quarters that motor buses would prove the "most suitable form of vehicle for public street conveyance", but considered that trams would continue to be "the most efficient and the cheapest means" of road transport. They accordingly recommended a large number of extensions to the London tramway system, including some lines in subway through central London, and surface tramways in, for instance, Whitehall and Victoria Street, and even in City streets such as Cannon Street. Some additional tramways were subsequently built. It was perhaps an unfortunate accident of transport history that the petrol-engined bus was not developed quite early enough to check the spread of the electric tram, at any rate in cities such as London with few wide thoroughfares.

10. As regards railways, the Commission referred to the manner in which deep-level tube railways had been separately designed by their various promoters without regard to a general plan for the area as a whole. It is of great interest to find in a report, made as long ago as 1905, an exposition of the essential differences between "urban" and "outer suburban" railway services and their separate functions and requirements. As the Commissioners put it:

> "It is obvious that the use of a line for one of these kinds of traffic may destroy or impair its utility for the other."

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This analysis is basic to the proposals of the London Plan Working Party published in 1949 (see paragraphs 28–31 below). The Commissioners suggested that tube railways should be extended from existing underground termini as surface railways, or even as tramways, to or beyond the suburbs, thus foreshadowing the extensions of the '20's and '30's. The inadequate provision for passenger traffic from Victoria to north of Charing Cross was noted. The imperfections of the Inner Circle service were the subject of comment, and the possibility of substituting a shuttle service between Edgware Road and South Kensington was mentioned in evidence to the Commission by Mr. R. W. Perks, M.P., previously the Chairman of the Metropolitan District Railway. The Commission was of the opinion that overcrowding in the peak hours would never be completely eliminated, but expressed the hope, only partially fulfilled fifty years later, that there would be no great delay before electric traction was adopted for suburban railway services throughout the London area.

11. The Commission had been directed by their terms of reference to advise upon the desirability of establishing some authority by which all schemes of railway—and tramway—development should be reviewed. The possibility that public enterprise might assume responsibility for public transport in London was adumbrated by the Commission, but they considered that this would, at the time, be premature. They emphasized, however, the need for amalgamation and interworking of separate transport systems, and thought that the formation of the Underground Electric Railways Company of London had been "of material assistance in raising the capital" for works which would be "of great public benefit". The Commission recommended the establishment of a Traffic Board, a consultative and advisory body, with responsibility for examining all proposals regarding transport and for preparing schemes, particularly with a view to facilitating amalgamation and inter-working.

12. The report of the Royal Commission is a mine of information about travel in London. A re-perusal is a salutary reminder of the wisdom, before deciding upon proposals for to-day, of always looking back to see what has been suggested in the past.

III. The Economic Background of the London Transport Area

13. The passenger transport system in any great urban aggregate such as London is clearly a reflex of the social and economic pattern, but itself, by a social process of mutual induction, influences and shapes that pattern. The size of the population and its distribution over the area; the shifts in that distribution from time to time; the mode of employment of the workers and the relationship of the place of work to the home; all have a direct bearing on the nature and extent of the local passenger services to be provided. In a large urban aggregate—or "conurbation" as the planners have it—people, whether at work or at play, cannot live a full life without local transport. Conversely, the transport system itself induces profound effects on social life by the facilities for getting to work and to places of amusement, as well as by the stimulus to social intercourse, it provides. The manner in which bus services have revolutionized life in country areas is a commonplace.

Accordingly, before proceeding to give an account of the system of transport and of travel in the London region, it is appropriate to deal first with the population and, in particular, the changes which have occurred in its size and in the pattern of its distribution over the area from time to time. A brief reference to changes in the industrial content of the London region is also relevant to an account of the economic background of which the transport system itself is an integral part.

14. The growth, since 1891, in the population of the County of London and Greater London and, since 1921, of the London Transport Area, is shown in Table I.

In Table I figures are shown for 1926 and 1937 because of the remarkable growth in population that took place during the intervening years, and for 1933 because the London Passenger Transport Board was formed in that year. It will be observed that:—

(*a*) During the twenty years 1891–1911 the population of the Outer Ring nearly doubled, thereby giving rise to the growing traffic problems to which the Royal Commission on London Traffic alluded;

(*b*) during the eleven years 1926–37 the population of the London Transport Area as a whole increased by 1,100,000; in the Outer Ring, however, the increase was over

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TABLE I.—*Population in Greater London and the London Transport Area*
(*Thousands*)

Year	Greater London: County of London	Greater London: Outer Ring	Greater London: Total	Greater London: Increase (+) or Decrease (−)	London Transport Area: Outer Country Area	London Transport Area: Total	London Transport Area: Increase (+) or Decrease (−)
Census Date—							
1891	4,228	1,406	5,634		..	..	
				(+) 947			
1901	4,536	2,045	6,581		..	..	
				(+) 670			
1911	4,522	2,729	7,251		..	..	
				(+) 229			
1921	4,485	2,995	7,480		..	..	
Mid-Year—							
1921	4,524	3,012	7,536		774	8,310	
				(+) 293			(+) 349
1926	4,631	3,198	7,829		830	8,659	
				(+) 531			(+) 699
1933	4,299	4,061	8,360		998	9,358	
				(+) 295			(+) 402
1937	4,094	4,561	8,655		1,105	9,760	
				(+) 73			(+) 128
1939	4,013	4,715	8,728		1,160	9,888	
				(−) 2,790			(−) 2,741
*1944 (Sept.)	2,217	3,721	5,938		1,209	7,147	
				(+) 847			(+) 829
*1945	2,601	4,184	6,785		1,191	7,976	
				(+) 1,606			(+) 1,775
1949	3,390	5,001	8,391		1,360	9,751	
				(−) 691			(−) 341
"Planned"	3,150	4,550	7,700		1,710	9,410	

* Civilian population only.

1,350,000 and in the outer country area 275,000, while the County showed a decline of over half a million;

(*c*) during the war, as a result of evacuation, the population of the London Transport Area fell from the peak figure of 9,888,000 in 1939 to the low level of 7,147,000, which was reached in September, 1944, shortly after the "flying bomb" episode;

(*d*) by mid-1949, the population had recovered to 9,751,000, compared with the latest "planned" figure of 9,410,000, and the numbers in the Outer Ring and beyond were materially larger than before the war.

15. In Appendix A, the changes in the distribution of the total population shown in Table 1 are analysed, according to "natural increase" and "net migration", for the County of London and the Outer Ring which together make up Greater London, and also for the part of the London Transport Area outside Greater London. The analysis discloses the following features:—

(*a*) The heavy "natural increase" which prevailed until shortly after World War I (col. 3);

(*b*) the resumption, between 1926 and 1937, of the marked outward movement from the County, chiefly to the Outer Ring, which had set in after the turn of the century (col. 6);

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(*c*) the pronounced movement of population from the provinces to the London region during the period 1926 to 1937—particularly during the great depression—which only slowed down as rearmament gathered way in 1938 and 1939 (col. 10);

(*d*) the convergence of the two migratory waves of population, (*b*) and (*c*), upon the Outer Ring and the outer country area, especially during the period 1926–37 (cols. 7 and 9).

16. The dominance of the factor of migration in the growth of London during the eleven years 1926–37 is brought out by Table 2.

TABLE 2.—*London Transport Area. Comparison of "Natural Increase" and Net Migration*—1921–39

Period Mid-year to mid-year	*Natural increase*	*Net migration*	*Total*
1921–26	303,000	46,000	349,000
	87	13	100
1926–33	263,000	436,000	699,000
	38	62	100
1933–37	122,000	280,000	402,000
	30	70	100
1937–39	75,000	53,000	128,000
	59	41	100
Total	763,000	815,000	1,578,000
	48	52	100

17. The impact of this rapid growth of population upon the local transport problem will be deduced from the further analysis in Table 3 of the increases in population.

TABLE 3.—*London Transport Area. Analysis of Growth in Population by Areas*, 1921–39

Period Mid-year to Mid-year	*County of London*	*Outer Ring*	*Outer Country Area*	*London Transport Area*
1921–26	(+) 107,000	(+) 186,000	(+) 56,000	(+) 349,000
1926–33	(−) 332,000	(+) 863,000	(+) 168,000	(+) 699,000
1933–37	(−) 205,000	(+) 500,000	(+) 107,000	(+) 402,000
1937–39	(−) 81,000	(+) 154,000	(+) 55,000	(+) 128,000
Total	(−) 511,000	(+) 1,703,000	(+) 386,000	(+) 1,578,000

The further piling up of population in the Outer Ring, as well as in the outer country area, during the period 1921–39 will be noted. Table 1 shows that, with the completion of post-war demobilization and the return of evacuated population and business undertakings, the total population is now little short of the pre-war peak figure of 9,888,000, but the centrifugal forces remain. The population of the County is over 600,000 below pre-war, but the Outer Ring and the outer country area show increases of 300,000 and 200,000 respectively over the 1939 figures. Planning policies, if and when they become effective, will involve reductions of the population in the County of a further $\frac{1}{4}$ million, and in the Outer Ring of nearly $\frac{1}{2}$ million, but an increase in the outer country area of 350,000 people. In the result, the total population of the London Transport Area should fall to 9,410,000. The changing population pattern is shown in the following percentage distributions for the three main subdivisions of the area (see Table 4).

The somewhat smaller planned population of 9,410,000 for the London Transport Area compared with the pre-war peak figure of 9,888,000 will entail a further marked shift to the outer country area beyond Greater London.

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TABLE 4.—*Percentage Distribution of Population over the London Transport Area*

Mid-year	*County of London*	*Outer Ring*	*Outer Country Area*	*Total*
1921	55	36	9	100
1933	46	43	11	100
1939	40	48	12	100
1949	35	51	14	100
"Planned"	33	49	18	100

18. The tidal waves of population movement, which characterized the period 1926–37, occurred when the total of unemployed insured persons in Great Britain swung between 1 and 3 millions. Then London was comparatively prosperous; its rate of unemployment was lower than that of the rest of the country, and it had little difficulty in absorbing the immigrants from the provinces seeking work in the rapidly-growing light industries of the outer parts of Greater London. As will be seen from Tables 5 and 6, there was, relatively to the rest of the country, an abnormal growth in the industrial population of the London Transport Area during the inter-war period.

TABLE 5.—*Population Insured Against Unemployment. Greater London Compared with Great Britain*

At Mid-year	*Number of Persons (thousands)*			*Per cent. of Great Britain*		
	Manufacturing Industries	*Other Industries and Services*	*Total*	*Manufacturing Industries*	*Other Industries and Services*	*Total*
1923	921	1,148	2,069	13·4	28·0	18·9
1927	989	1,271	2,260	14·2	27·4	19·5
1937	1,253	1,660	2,913	17·2	26·9	21·6
1939	1,313	1,679	2,992	17·6	26·3	21·6
1947	1,245	1,637	2,882	14·9	23·4	18·7

Note.—Owing *inter alia* to changes in the scope of compulsory unemployment insurance, the figures for 1947 shown in the above table are not strictly comparable with those for 1939 and earlier years.

TABLE 6.—*Increases in Population Insured Against Unemployment. Greater London Compared with Great Britain*

Period	*Greater London Increases (Percentages of Great Britain Increases shown in italics)*			*Great Britain Increases*		
	Manufacturing Industries	*Other Industries and Services*	*Total*	*Manufacturing Industries*	*Other Industries and Services*	*Total*
1923–27	68,000	123,000	191,000	84,000	550,000	634,000
	81	*22*	*30*			
1927–37	264,000	389,000	653,000	343,000	1,521,000	1,864,000
	77	*26*	*35*			
1937–39	60,000	19,000	79,000	185,000	221,000	406,000
	32	*9*	*19*			

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It will be seen that, between 1927 and 1937 (figures for 1926 are not readily available), the population of Greater London employed in manufacturing industries increased by 264,000, or 27 per cent. Table 6 shows that this increase represented no less than 77 per cent. of the total increase in the labour force engaged in manufacturing industries in Great Britain.

19. This growth in the insured population employed in manufacturing industries in the London region was paralleled by rapid factory development, as shown in Table 7.

TABLE 7.—*Analysis of Factory Development (excluding factories employing less than 25 persons). London Transport Area Compared with Rest of Great Britain 1932–38 (inclusive)*

Type of Development	*London Transport Area*					*Rest of Great Britain*	*L.T. Area as a percentage of Great Britain*
	County of London	*Outer Ring*	*Greater London*	*Outer Country Area*	*Total*		
Factories Opened—							
New	583	371	954	128	1,082	1,449	43
Transfers	91	259	350	20	370	115	76
Extensions	125	165	290	62	352	828	30
Branches	72	63	135	16	151	436	26
Total Opened	871	858	1,729	226	1,955	2,828	41
Deduct—							
Factories Closed	778	229	1,007	49	1,056	1,888	36
NET INCREASE in the number of factories	93	629	722	177	899	940	49

Source of data: Annual Survey of Industrial Development, prepared by Board of Trade.

The great increase in the population in the Outer Ring (Table 3) was thus accompanied by a net increase of 629 in the number of factories in that area. For the London Transport Area as a whole the net increase was 899, compared with only 940 for the rest of Great Britain. Yet, in terms of population, the London Transport Area represented no more than one-fifth of the whole country.

20. The unevenness with which industrial development is spread over London and its concentration in certain areas have given rise to difficult transport problems, particularly in the peak hours, which it has been the purpose of the campaign for the "staggering" of working hours to alleviate. The extent of this disequilibrium is shown in Table 8. This has been based upon material obtained from the Ministry of Labour, who have kindly given consent to its utilization in this paper.

The following features are of interest:—

(*a*) The degree of industrialization, in terms of the relationship between numbers employed in manufacturing establishments and the resident population, which is of a similar order in both the Outer Ring and the outer country area, but somewhat higher in the County of London;

(*b*) the high level of industrialization in the western sectors of both the Outer Ring and the outer country area (in the latter case over double the figure for the area as a whole), which reflects the growth in the inter-war years of the factory concentrations along the Great West Road at Brentford, along Western Avenue at Park Royal, and further west at Slough; they have given rise to serious peak-hour traffic problems which mainly affect the road services;

(*c*) the heavy industrial concentrations in the eastern sector of the Outer Ring, which have led to peak-hour problems on the Barking Line, and in the traffic to the docks which is mainly the concern of the road services.

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TABLE 8.—*Industrialization in the London Transport Area (December, 1948)*

	Total Resident Population (000)	*Manufacturing Establishments employing over 10 persons*			*Persons Employed as a percentage of Total Resident Population (Per cent.)*	*Manufacturing Establishments employing over 20 persons (Numbers)*
		Number	*Persons employed (000)*	*Average size (Numbers)*		
County of London	3,374	7,027	546	78	16·2	4,643
Outer Ring—						
South-East	460	232	34	147	7·4	161
South	656	549	53	97	8·1	376
South-West	624	636	64	101	10·3	446
West	564	661	121	183	21·5	506
North-West	837	917	132	144	15·8	719
North	955	963	119	124	12·5	681
North-East	392	287	30	105	7·7	209
East	488	551	104	189	21·3	442
	4,976	4,796	657	137	13·2	3,540
Greater London	8,350	11,823	1,203	102	14·4	8,183
*Outer Country Area**—						
South-East	183	114	27	237	14·8	80
South	207	146	11	75	5·3	100
South-West	164	172	19	110	11·6	117
West	152	447	45	101	29·6	329
North-West	452	652	82	126	18·1	460
North	154	190	21	111	13·6	151
North-East	123	106	10	94	8·1	71
East	120	25	8	320	6·7	23
	1,555	1,852	223	120	14·3	1,331
*London Transport Area**	9,905	13,675	1,426	104	14·4	9,514

* Includes the whole of certain towns on the periphery of the London Transport Area.

21. It was this drift of population to London and the Home Counties, with a concurrent growth of industry, that gave rise to great concern in the years before World War II, and led to the appointment of the Royal Commission on the Distribution of the Industrial Population, presided over by Sir Montague Barlow. The report of this inquiry paved the way for the town and country planning policies of to-day. It is against this rapidly-changing background of population and industry that the development of local passenger transport facilities for Londoners must be viewed.

IV. The Basic Types of Travel in the London Transport Area

22. It is helpful to an understanding of the functions of the systems of the London Transport and Railway Executives within the London Transport Area to recognize the distinctions between the three basic types of journey for which services have to be provided. They are:—

(*a*) The relatively short in-town journeys, or local journeys in the suburbs or the country area, which are mainly the province of road transport, whether bus, tram, or trolleybus;

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(*b*) the longer urban journeys, chiefly between the outer suburbs within a 10–12 miles radius and the centre, i.e., broadly within the built-up area of Greater London, which are mainly the province of the railways, and especially of the tube railways;

(*c*) the journeys to and from the outer suburbs beyond the 10–12 miles radius which are again the province of the railways, and more particularly of the outer suburban services of the Railway Executive.

In addition to the above, there are the journeys on the coach which, while it cannot vie with the railway in speed over a given distance, often provides a missing transport link in outer areas perhaps not conveniently served by the suburban railway system. Against the longer time of journey must be set the advantage to the passenger of the closer approximation to a "door-to-door" service which the coach frequently provides.

23. The differences in function of the basic types of local transport are clearly illustrated by the figures quoted in paragraph 45 below of the average distance travelled per passenger journey originating. To-day the figures are:—

	Miles
Road Services (excluding Green Line Coaches)	2·2
London Transport Railways	6·0
Suburban Services of the Railway Executive	10·3
Green Line Coaches	14·0

The differing functions of the various forms of transport are also reflected in the average scheduled speeds, which for London Transport services are to-day as follows:—

	Miles per Hour
Road Services (excluding Green Line Coaches)	11·3
Railways	20·2
Green Line Coaches	18·4

No comparable figures are available for Railway Executive suburban services.

24. Comparisons between the distributions of traffic at each rate of fare on London Transport railways and on the Central Road Services, shown in Table 18, afford a further illustration of the essential differences between traffics in categories (*a*) and (*b*).

Thus, the preoccupation of the road services with relatively short-distance traffic is borne out by the fact that, to-day, half the passengers on the Central Road Services are carried at the minimum fare of 1½*d.*, whilst nearly 90 per cent. pay 4*d.* fares or less, and ride some 3 miles or less per journey. Up to this distance, travel by road services, by and large, is quicker than by rail. But, for transport over longer distances, the road services, apart from the generally greater time taken, are in any event subject to an over-riding limit imposed by the physical capacity of the urban road system. Services of buses over a long stretch of main road can hardly exceed the equivalent of three buses a minute, or 180 an hour; this represents a carrying capacity of, say, 11,000 passengers in the hour, but not all to the same destinations. In the case of trolleybuses, with a higher carrying capacity, the hourly maximum passenger traffic flow might be about 13,500. These figures may be contrasted with a peak service of 40 trains an hour on London Transport railways, with a potential carrying capacity, including standing passengers under tolerable conditions, of about 32,000 or, say, two-and-a-half or three times that of the most intensive practicable road service. Traffic flows approaching this intensity are dealt with to-day on the London Transport railways for short periods in the peak hours. Clearly the roads could not handle traffic on this scale. It is evident that the inner-London rail and road services, for which London Transport is primarily responsible, are complementary in providing facilities for regular travel to and from work or pleasure. The important ancillary function of road services as feeders to the rail services will also be obvious.

25. Broadly speaking, the fare is the same on London Transport services whether by rail or by road. The average charge before the war over all classes of traffic was about ·8*d.* per mile, based upon a scale of ordinary fares at roughly 1*d.* per mile. As a result of increases in fares at various times, the average charge since 1947 has been roundly 1·1*d.* per mile, with a minimum

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ordinary fare of 1½*d*. There are, admittedly, a number of historical anomalies in fares inherited from pre-1933 days which diverge from the general pattern. Discussion of them would be beyond the scope of this paper. They will be largely cleared up, it is to be hoped, as a result of the review of fares and charges now in progress. Though he may be influenced by abnormally low fares to select a longer route, the passenger will ordinarily choose the quickest mode of transport for his journey. Thus, as Table 18 shows, 31 per cent. of railway journeys are at fares of 5*d*. to 7*d*. inclusive (4*d*. to 6*d*. pre-war), compared with 10 per cent. on road services. With fares over 7*d*. (6*d*. pre-war) the difference is more striking; for railway journeys the proportion is 24 per cent. and for road services a mere 1 per cent.

26. Travel in any one of categories (*a*), (*b*), and (*c*) is, of course, by no means solely confined to the appropriate means of transport; there are overlaps. Nevertheless, the figures quoted do, in fact, accord with fundamental differences in the character of the services, particularly as regards the time of journey. With categories (*a*) and (*b*), there is the over-riding consideration of the physical ability of the services—road as well as rail—to handle the traffic.

27. It is convenient at this point to refer to the factor which is basic to the finances of a co-ordinated local transport system in a great city such as London. It has been shown that tube railways are indispensable in handling the daily traffic to and from work, but they are costly. Before the war, the average cost of constructing and equipping a mile of tube railway, including signalling and rolling stock, with stations about ½ mile apart on the average, was roundly £800,000; to-day the corresponding figure is over £1¾ millions. For "full size" tubes capable of taking main line rolling stock, with stations further apart, the figure is between £2½ and £3 millions. Road services, although subject to heavy taxation for fuel and licensed vehicle duties, give a better return than railways. The finances of the Underground Company were based on the pooling of the net revenues derived from the rail and road services under its control. Thus, the more profitable bus services helped to sustain the less profitable tube services. This principle continued to operate under the London Passenger Transport Board, when the whole of the local services—rail and road, including the main line suburban services—were treated as forming a single undertaking for financial purposes. As Mr. Pick once said: "It requires certainly two, and possibly three, road miles to support one rail service mile." The relativity may have changed with the passage of years, but the principle is still valid.

28. It remains to comment upon the characteristic features of travel on the "urban" and "outer suburban" railway services—categories (*b*) and (*c*) in paragraph 22. The distinction between these two types of service is fundamental to the proposals of the London Plan Working Party which constitute, in effect, a master plan for local railway development in the London region for the next 30 years. While, logically, it is a question of function, to the passenger it becomes essentially a matter of the time and convenience of journeys.

29. In the case of the urban service, a heavy volume of passengers has to be moved from the inner suburban area (up to 10–12 miles from the centre), and distributed in detail over the in-town area. This involves heavy simultaneous boarding and alighting at busy stations, especially exchange stations such as Oxford Circus, Piccadilly Circus, Holborn, and Charing Cross. It entails a high frequency of service all day (up to 40 trains an hour during peak periods); frequent stops; and a high overload capacity represented by ample standing room. Under such conditions of travel, the length of journey should not exceed 12 or, possibly, 14 miles from the centre, giving a journey time of 30–40 minutes.

Such conditions would be unacceptable for journeys from the outer suburbs for which the Railway Executive provide most of the services. Here the need is for rapid movement of traffic in bulk to and from the central area and outer suburbs, and towns further afield but still within the sphere of influence of the metropolis. These heavy traffics are uni-directional and there is little simultaneous boarding and alighting at stations. Thus, the chief characteristics of the services are comparatively high speed (dependent on fewer stops than the urban type of service); high seating capacity; and a lower frequency (up to a maximum of, say, 25 trains an hour) than is required for the urban type of service.

It will be apparent that the different requirements of the urban and outer suburban services demand different designs of rolling stock, but this was not why a smaller tunnel diameter was adopted for the tube railways. The primary consideration was the marked saving in the high cost of tube construction.

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30. From this analysis it will be apparent, for example, that the mere extension of the London Transport railway services, which reach out 12 miles or so from the centre, affords no answer to a demand for an improved railway service in areas further out. The time of journey for the all-stopping urban service, in relation to the length of journey, would become intolerable, quite apart from the obvious limit to the capacity of the trains. Indeed, as the London Plan Working Party recognized in their report, certain of the London Transport services have been allowed to go too far out. The Bakerloo service to Watford is an example.

31. As already remarked, it is upon this basic analysis of function that the schemes embodied in the report of the London Plan Working Party were founded. The incompatibilities of the urban and outer suburban services are such that the same line cannot effectively be used for both types of service. Those who desire further information about the development of London's urban and suburban railways will find the Working Party's report, and the sketch maps appended to it, of considerable interest.

V. The Transport System and the Services Provided

32. A general indication of the physical expansion of London's transport system during the first half of the century is afforded by the growth in the route miles of railways open for passenger traffic, and of roads over which services are operated, shown in Table 9. In this and following tables, the years "1933–34" and "1938–39" are from mid-year to mid-year, i.e., the accounting year of the London Passenger Transport Board, which took over on 1st July, 1933. After 1940, the calendar year was employed.

TABLE 9.—*Greater London and London Transport Area. All Services: London Transport Executive and Railway Executive*

Route Mileage

Year	*London Transport Executive*				*Suburban Services of Railway Executive*		*All Railway Services*	
	Railways		*Buses and Coaches*	*Trams and Trolley-buses*				
	Steam	*Electric*			*Steam*	*Electric*	*Steam*	*Electric*
Greater London—								
1902	56	12	300	149		532		600
1911	11	97	300	347		555		663
1921	7	108	643	344		538		653
1933–34	2	138	1,192	344	240	286	242	424
1938–39	2	138	1,314	344	231	303	233	441
London Transport Area—								
1933–34	26	144	2,396	344	631	387	657	531
1938–39	26	144	2,513	344	542	480	568	624
1949	32	189	2,672	344	452	498	484	687

Note.—The railway mileage figures for years before 1949 have been adjusted throughout to reflect the present division of joint lines between the London Transport and Railway Executives.

The increase in route miles on London Transport Railways since before the war includes mileage on lines transferred from the Railway Executive consequent upon surface extensions to the tube system.

33. Since the beginning of the century the total route miles of London Transport railways, which are more especially concerned with "urban" travel as previously defined, have been more than doubled. The un-electrified mileage lies almost entirely between Rickmansworth and Aylesbury, where the type of service strictly falls in the "outer suburban" category. The figures in the table reflect the major developments associated with the rise of the Underground Group, including both the construction and extension of the tube railways, and the administrative and financial unification of rail and road services to which reference is made in the Introduction.

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The undertakings outside the Underground Group were not, however, idle in the years before 1933, when the London Passenger Transport Board was set up. Route mileage on the Railway Executive system, concerned mainly with the "outer suburban" passenger, has naturally remained almost static, although improvements have been made in the services. The lines were already there as part of the main line network, but the Southern Railway suburban services were completely electrified, and by 1933 electric operation had been extended to the coast at Brighton and Worthing; by the outbreak of war further important extensions of electrification, including those to Hastings, Eastbourne, Bognor, and Portsmouth on the Southern Railway, had been carried out. The Metropolitan Railway had also been electrified as far as Rickmansworth and Watford. As regards road services, the municipal tramways were electrified in the early years of the century, whilst the phenomenal growth in the mileage of routes covered by road services after 1911 is indicative of the adaptability of the motor bus. This vehicle, unlike the tram and the trolleybus, is untrammelled either by rails, or by overhead wires or conduits for the supply of electric power.

The principal stages in the continuous development of London's railway system, including the conversions from steam to electric working, are recorded in Appendix B.

34. Other physical elements of the transport system are the stations on the railways and the vehicles employed on the services, both rail and road. For convenience of reference their numbers are summarized in Tables 10 and 11.

TABLE 10.—*London Transport Executive and Railway Executive: Number of Railway Stations*

Year	*London Transport Executive*	*Suburban Services of Railway Executive*	*Total*
Greater London—			
1902	97	430	527
1911	155	443	598
1921	167	411	578
1933–34	188	430	618
1938–39	187	439	626
London Transport Area—			
1933–34	199	641	840
1938–39	198	652	850
1949	231	576	807

Note.—The numbers of railway stations for years before 1949 have been adjusted to reflect the present division of joint lines between the London Transport and the Railway Executives.

The increase in the number of London Transport stations since before the war includes stations transferred from the Railway Executive consequent upon surface extensions of the tube system.

TABLE 11.—*London Transport Executive: All Services. Number of Passenger Vehicles*

Year	*Railways*	*Buses and Coaches*	*Trams and Trolley-buses*	*Total*
Within Greater London—				
1901	1,096	3,746	1,621	6,463
1911	1,795	2,748	2,789	7,332
1921	1,991	3,890	2,984	8,865
Within London Transport Area—				
1933–34	3,156	5,976	2,621	11,753
1938–39	3,703	6,389	2,727	12,819
1949	3,941	7,201	2,594	13,736

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35. Collectors of statistics who would like to know, for example, the numbers of London Transport lifts, escalators, garages, and tram and trolleybus depots, are referred to the Annual Reports of the London Passenger Transport Board and the British Transport Commission. It may be added that, at the end of 1949, the number of staff employed by London Transport was just under 100,000.

36. To members of the public, the route mileage shown in Table 9 is only of interest, particularly as regards railways, by virtue of its implication of the possibility of a service. To them, it is the service itself that matters. The simplest overall measure of service is the aggregate of the "service car miles", i.e., the total miles run by the vehicles in passenger service during the year. These are shown for London Transport services in Table 12, together with the figures per head of population.

TABLE 12.—*All Services: London Transport Executive.*

Service Car Miles Run and Total Car Miles Per Head of Population

		Service Car Miles Run (Millions)				*Per Head of Population*		
Year	*Population (000)*	*Railways*	*Buses and Coaches*	*Trams and Trolleybuses*	*Total*	*Railways*	*Road Services*	*Total*
Greater London—								
1901	6,581	33	75	32	140	5·0	16·3	21·3
1911	7,251	72	52	80	204	9·9	18·2	28·1
1921	7,536	84	107	88	279	11·1	25·9	37·0
London Transport Area—								
1933–34	9,386	152	280*	105	537	16·2	41·0	57·2
1938–39	9,859	174	286*	113	573	17·6	40·5	58·1
1948	9,620	224	311*	113	648	23·3	44·1	67·4
1949	9,751	229	312*	112	653	23·5	43·5	67·0

* The figures for the coaches alone are 31, 27, 22 and 22 millions respectively.

37. The car miles run on the suburban services of the former main line companies are available only for the period mid-1933 to mid-1939, during which the pooling scheme, referred to in paragraph 4, was in operation. This was suspended at the outbreak of war, when the undertakings of the main line railways and the Board were brought under Government control, which continued until nationalization. With the absorption of the finances of the main line railways and London Transport into those of the British Transport Commission, figures of the mileage operated by the main line companies on local services within the London Transport Area were no longer required. Their compilation, which was expensive and would have served no particular administrative purpose, was therefore abandoned.

Table 12A completes the picture as far as figures are available.

TABLE 12A.—*All Services: London Transport Executive and Railway Executive.*

Service Car Miles Run and Total Car Miles Per Head of Population

	Service Car Miles Run (Millions)					*Per Head of Population*				
	London Transport		*Suburban Services of Railway Executive*	*All Railway Services*	*All Services*	*London Transport*		*Suburban Services of Railway Executive*	*All Railway Services*	*All Services*
Year	*Rail*	*Road*				*Rail*	*Road*			
1933–34	152	385	246	398	783	16·2	41·0	26·2	42·4	83·4
1938–39	174	399	273	447	846	17·6	40·5	27·7	45·3	85·8

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The continuous expansion of services over the years is noteworthy. Even during the inter-war period, when, at one time, the population increased by half-a-million in five years, the overall standard of service per head of the population was increased. The growth of the London Transport services has been 14 per cent. since before the war; but this includes surface extensions of the tube services which have replaced former main line suburban steam services.

38. These figures of route mileage, railway stations, passenger vehicles, and car miles, afford a general picture of the development of railway services in the London Transport Area during the first half of the century. A different measure of the standard of railway service in the Area is afforded by the number of stops made at stations by passenger trains per 10,000 of population. Such figures of the relative standards of railway service in eight sectors of London, in the outward direction during the two peak hours 4.30 p.m. to 6.30 p.m., were included in the Report of the London Plan Working Party. Table 13 is based on this analysis. It is unfortunate that comparable figures for the beginning of the century are not readily available. This must be left as an interesting, if somewhat laborious, piece of research for the student.

TABLE 13.—*London Transport Executive and Railway Executive. Station Stops per* 10,000 *Population* (*June*, 1948)

(Weighted in accordance with the carrying capacity of the train service)

Sector	*County of London*	*Outer Ring*	*Greater London*	*Outer Country Area*	*London Transport Area*
(1) South-East	14·2	15·6	14·7	13·7	14·6
(2) South	17·9	13·4	14·6	14·4	14·6
(3) South-West	17·6	14·3	15·7	16·3	15·7
(4) West	22·1	14·2	17·7	10·5	17·2
(5) North-West	20·2	19·3	19·6	9·8	17·3
(6) North	13·0	9·1	10·4	9·5	10·3
(7) North-East	16·0	12·0	12·5	8·1	11·7
(8) East	23·1	10·3	13·7	11·1	13·3
(1–3) Southern Areas	15·7	14·3	15·0	14·6	14·9
(4–8) Northern Areas	18·6	13·2	14·9	9·8	14·2
	17·2	13·6	14·9	11·6	14·5

Those who live in the various sectors may be left to draw their own conclusions.

39. As already explained, no figures of car mileage on the main line suburban services within the London Transport Area are available for periods before 1933–34. Sir Edgar Harper, however, gave figures of the number of suburban trains arriving at the main line termini before 10.30 a.m., and it seemed desirable to provide similar information for the present day. The Railway Executive have been kind enough to furnish this information, which is summarized in Table 14. The figures for 1949 are not strictly comparable with those for 1903, as the former include long-distance trains as well. But the number of these arriving before 10.30 a.m. is not large, whilst daily travel to and from the coast and other distant towns had not become an established habit in the early days of the century. With the extensions of electrification on the Southern Region it is difficult, if not impossible, to-day to determine what exactly is a suburban and what is a main line train. Such figures, of course, afford no more than a very broad indication of the services provided. Some trains to-day are considerably longer than in 1903 and their carrying capacity is greater. Subject to this qualification, it will be noted that, whilst the number of trains arriving at West End termini has approximately doubled, the number arriving at City termini has declined slightly.

VI. VOLUME AND CHARACTER OF TRAVEL IN LONDON

40. Before presenting figures to illustrate the volume and character of travel in London, it is perhaps desirable to lay stress on the point that, as in most large-scale organizations in this

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TABLE 14.—*Number of Trains Arriving at the Main Line Termini Before* 10.30 *a.m.*

	1903	1949	*Increase* (+) *or Decrease* (−)
City—			
Blackfriars and Holborn Viaduct	69	83	(+) 14
Cannon Street	37	89	(+) 52
London Bridge	96	157	(+) 61
Fenchurch Street	79	42	(−) 37
Liverpool Street	149	154	(+) 5
Broad Street	102	46	(−) 56
King's Cross (50 per cent.)	19	25	(−) 56
Moorgate	62		
St. Pancras (50 per cent.)	7	10	(+) 3
	620	606	(−) 14
West End—			
Charing Cross	45	90	(+) 45
Waterloo	96	192	(+) 96
Victoria	83	143	(+) 60
Euston	17	29	(+) 12
Marylebone	—	23	(+) 23
Paddington	9	51	(+) 42
King's Cross (50 per cent.)	18	25	(+) 7
St. Pancras (50 per cent.)	7	9	(+) 2
	275	562	(+) 287
Total	895	1,168	(+) 273

Note.—The number of trains arriving at King's Cross and St. Pancras has been apportioned equally between the City and West End.

country, transport statistics are normally collected, not to gratify general curiosity, but to serve the needs of administrative and financial control. In Underground days, the practice of statistical measurement was of long standing. A whole series of indices of "output" and "efficiency" was evolved; these have long been accepted by all concerned in London Transport as essential to the effective control of its manifold activities. Nevertheless, statistics have always been regarded as made for London Transport and not London Transport for statistics. A proper concern for economy in this respect was part of the Underground tradition which the London Passenger Transport Board and the London Transport Executive inherited. To the sociologist and the planner there may well seem to be gaps in the available data. Many of these are of little consequence in the day-to-day running of this great complex of services. In any event, much information of general social significance, especially in the context of "planning", could not be obtained solely from the material derivable from the daily operations of London Transport. For such data recourse must be had to "social survey" methods, that is to say, to direct contact with the potential travelling public, whether they use the public transport services or not. Accordingly, last year London Transport organized, with the help of Research Services Limited, house-to-house visits to a representative sample of households spread over Greater London, and in three towns, namely, Dartford, Reigate and St. Albans, in the outer country area. A first appreciation of the results of the London Travel Survey has recently been published, but there is much material still to be studied. With the permission of the London Transport Executive this valuable source of information has been drawn upon to elucidate particular points in what follows.

41. The basic statistics of traffic carried by the public passenger transport agencies consist of the number of passengers who buy a ticket, a return journey counting as two, or who, on the railways, take out season tickets, which are conventionally rated at the equivalent of 600 journeys per annum. In the jargon of railway statistics, the unit is styled a "passenger journey originating",

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or, more popularly, a "ride". It is, of course, not a "journey" in the ordinary sense of movement from door to door, or even from boarding point to alighting point; a change from one form of transport to another, e.g., rail to bus, normally requires two tickets and so counts as two "passenger journeys originating", or, in other words, two "rides". Again, when through tickets are available from a station on the London Transport system to one on the Railway Executive's suburban system or vice versa, a count of "passenger journeys originating" will clearly not afford a measure of the actual number of passengers carried on each system. Such points are only of material significance on the railways; on the road services the total number of passenger journeys originating is, to all intents and purposes, the same as the total number of passengers carried. With these qualifications the aggregate figures of passenger journeys originating, shown in Table 15, afford a useful measure, for comparative purposes, of the general level of traffics. When related to the population, they provide a rough and ready index of the travel habit, which, like other simple measures, such as the crude death rate, has its uses for broad comparisons.

TABLE 15.—*All Services: London Transport Executive and Railway Executive Passenger Journeys Originating and Rides Per Head of Population*

		London Transport Executive					*Suburban Services of Railway Executive*	*All Services*	
Year	*Population (000)*	*Railways*	*Buses and Coaches*	*Trams and Trolley-buses*	*Total*	*Per Head of Population*		*Total*	*Per Head of Population*
		(Millions)					*(Millions)*	*(Millions)*	
Greater London—									
1901	6,581	124	470	341	935	142	233	1,168	177
1911	7,251	297	401	822	1,520	210	292	1,812	250
1921	7,536	381	932	1,009	2,322	308	424	2,746	364
London Transport Area—									
1933–34	9,386	451	2,082	1,029	3,562	380	491	4,053	432
1938–39	9,859	511	2,223	1,087	3,821	388	548	4,369	443
1948	9,620	650	2,745	1,210	4,605	479	437	5,042	524
1949	9,751	641	2,745	1,183	4,569	469	431	5,000	513

Two features stand out in regard to the travel habit in terms of rides per head: the continuous increase over the years, and above all the sharp rise compared with before the war. The set-back in 1949 was slight, and was associated, among other things, with the increased volume of goods that are now available for personal consumption. The effect is two-fold: the purchasing power available for pleasure travel is reduced while, at the same time, the wider distribution of goods which now obtains renders it unnecessary for the housewife to travel so far afield, and so frequently, as she was obliged to do in the early post-war years.

42. Rides, however, are not an adequate measure of volume of travel or of user of the services which must, of course, take account of the distances travelled. Computed figures of passenger miles, that is, the total miles travelled by all the passengers, are therefore shown in Table 16. The estimates for the suburban services of the Railway Executive are given with reserve, and must be regarded as indicative of the order of magnitude only.

The upward movement, both in passenger journeys originating and in passenger miles, from the formation of the London Passenger Transport Board until the war was slow. Since before the war, however, the rides per head on all services have risen by 16 per cent. and the passenger miles per head by 25 per cent. For London Transport, the corresponding figures are 21 and 46 per cent. The total daily movement of 12 million rides pre-war has now grown to 13¾ millions.

43. The distribution of passenger miles by forms of transport, shown in the above table, measures the contribution which each form of transport makes in carrying passenger traffic in the London Transport Area. In terms of passenger miles, traffic is about equally divided between the rail and road services; the decline since before the war in the proportion of the total traffic

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TABLE 16.—*All Services: London Transport Executive and Railway Executive Passenger Miles in Total and Per Head of Population*

Year	Population (000)	London Transport Executive: Railways (Millions)	Buses and Coaches (Millions)	Trams and Trolley-buses (Millions)	Total (Millions)	Per Head of Population	Suburban Services of Railway Executive (Millions)	All Services: Total (Millions)	All Services: Per Head of Population
1933–34	9,386	2,113	4,139	2,051	8,303	885	—	—	—
1938–39	9,859	2,421	4,318	2,115	8,854	898	5,102	13,956	1,416
		17	31	15	63		37	100	
1948	9,620	3,834	6,298	2,754	12,886	1,339	4,364	17,250	1,793
		22	37	16	75		25	100	
1949	9,751	3,820	6,267	2,679	12,766	1,309	4,426	17,192	1,763
		22	36	16	74		26	100	

carried by the Railway Executive suburban services will be noted. It must, however, be remembered that, with extensions of the tube railways over certain surface lines of the Railway Executive, these lines have become part of the London Transport system. Nevertheless, in terms of passenger miles, the Railway Executive services carry a quarter of the total traffic, both rail and road. On the London Transport system alone, the railways carry about 30 per cent. of the traffic.

44. Although there was a slight set-back in traffics in 1949 compared with the previous year (which was a leap year), it is evident that a new high level of travel has been established in the London Transport Area. It seems reasonable to associate this phenomenal growth with the wider diffusion of purchasing power among the wage-earning classes in the post-war world. Other factors must be full employment, and the outward spread of the population to the Outer Ring and beyond (see paragraph 17).

45. From Tables 15 and 16 it is possible to derive the estimated average distance travelled per passenger journey on each form of transport; the figures are given in Table 17.

TABLE 17.—*All Services: London Transport Executive and Railway Executive (excluding Green Line Coaches). Average Distance Travelled per Passenger Journey (Miles)*

Year	London Transport Executive: Railways	Buses	Trams and Trolley-buses	Total	Suburban Services of Railway Executive	All Services
1933–34	4·7	1·9	2·0	2·3	—	—
1938–39	4·7	1·8	1·9	2·3	9·3	3·1
1948	5·9	2·2	2·3	2·7	10·0	3·4
1949	6·0	2·2	2·3	2·7	10·3	3·4

On the Green Line Coaches, the average distance travelled has risen from 12 miles in 1938–39 to 14 miles in 1948 and 1949. A minimum fare of 1*s.* 6*d.* (9*d.* in the country area) is charged on the coaches, so that coach journeys are longer on the average than journeys on the suburban services of the Railway Executive.

46. It must again be emphasized that the journey by the passenger may be made up of rides on two or more different vehicles or forms of transport (see paragraph 41). Thus, the average length of "journey" shown for a particular form of transport is less than the length of journey from the point of view of the passenger. The London Travel Survey shows that only 56 per cent. of workers using public transport make the journey to work with no change; 32 per cent.

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make one change; and 10 per cent. two changes. Nevertheless, as already pointed out (paragraph 23), the figures of the average length of journey are illustrative of the different functions of the several forms of transport. They also show how on each form of transport the average length of journey, which was more or less static between 1933 and 1939, has risen. On the London Transport services the increase has been roundly between 15 and 30 per cent., according to the form of transport.

47. These differences in the average length of journey reflect the numbers of journeys made at different rates of fare, for which figures relating to the London Transport Railways and Central Road Services are given in Table 18.

TABLE 18.—*London Transport Executive: Railways and Central Road Services (i.e., excluding Country Buses and Coaches). Distribution of Traffic at Each Rate of Fare based on two "Test" Weeks in each year. (Season Tickets excluded)*

		1939				1949			
		Railways		*Central Road Services*		*Railways*		*Central Road Services*	
Distance (miles)	*Fare* 1939 d.	*Fare* 1949 d.	*Journeys* (000)	*Per cent. of total*	*Journeys* (000)	*Per cent. of total*	*Journeys* (000)	*Per cent. of total*	*Journeys* (000)	*Per cent. of total*
1	1	1½*	2,309	15·3	67,408	59·2	2,320	12·1	68,830	50·1
2	2	2½*	2,820	18·7	29,749	26·1	3,135	16·3	39,218	28·5
3	3	4	3,161	21·0	8,956	7·9	3,352	17·4	14,490	10·6
			8,290	55·0	106,113	93·2	8,807	45·8	122,538	89·2
4	4	5	2,102	14·0	4,559	4·0	2,428	12·6	7,446	5·4
5	5	6	1,487	9·9	1,509	1·3	1,990	10·4	3,778	2·8
6	6	7	1,176	7·8	1,110	1·0	1,441	7·5	2,236	1·6
			13,055	86·7	113,291	99·5	14,666	76·3	135,998	99·0
Over 6	Over 6	Over 7	2,002	13·3	515	0·5	4,566	23·7	1,403	1·0
Total			15,057	100·0	113,806	100·0	19,232	100·0	137,401	100·0

* Journeys at 1½*d.* and 2½*d.* fares include journeys at 1*d.* and 2*d.* fares respectively, mainly by children.

These distributions have been discussed in paragraphs 24 and 25.

48. Table 19 shows the passenger miles per car mile or, in other words, the average load per passenger vehicle on London Transport services.

TABLE 19.—*London Transport Executive. Average Load per Passenger Vehicle*

Year	*Railways*	*Buses and Coaches*	*Trams and Trolleybuses*	*Total*
1933–34	14·9	14·8	19·6	15·8
1938–39	15·2	15·1	18·8	15·8
1948	18·4	20·3	24·3	20·4
1949	18·0	20·1	24·0	20·1

Note.—In the case of Railways, the "car miles" used to calculate the above figures are those operated by both London Transport and Railway Executive trains over the London Transport system, as distinct from those shown in Table 12, which are the car miles run by London Transport trains over both the London Transport and the Railway Executive systems.

The "passenger miles" used in the calculations are those quoted in Table 16, which make no allowance for clearances of traffic with the Railway Executive. For 1948 and 1949 the average load per passenger vehicle on London Transport Railways, allowing for these clearances, was 19·4 and 18·8 respectively. Comparable figures cannot be obtained for the earlier years.

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These overall average figures are, of course, of little administrative value, for they obscure the incidence of traffics at particular points and times throughout the day. Analyses of loadings provide this information, which is of greater practical interest to the transport operator. Such data are in fact collected by direct observation, and afford a basis for making current adjustments in services to meet traffic needs.

49. The massive yearly figures of the volume of travel conceal a complex of movements, hourly, daily, and seasonal, distorted from time to time by the vagaries of that national institution, the weather. These movements are of the greatest significance to the provider of public passenger transport services.

Hourly Incidence of Traffics

50. The uneven manner in which passenger traffic is distributed over the day is illustrated by the figures in Table 20, taken from the Travel Survey, relating to "regular" journeys on London Transport and Railway Executive services within the London Transport Area. For purposes of the survey, regular journeys were taken to be not only those to and from work, but also journeys made regularly at least once a week for any other purpose, e.g., shopping, going to school, entertainment (theatres or cinemas) or sport.

TABLE 20.—*London Transport Area. Distribution of Regular Journeys by Periods of the Day and Days of the Week*

Time of Commencement of Journey	*Rail Services*			*Road Services*		
	Mondays to Fridays	*Saturdays*	*Sundays*	*Mondays to Fridays*	*Saturdays*	*Sundays*
	%	%	%	%	%	%
At and before 7 a.m.	7	6	3	5	4	2
7.01–8 a.m.	16	13	6	14	8	2
8.01–9.30 a.m.	21	15	4	16	10	3
9.31–12 noon	3	12	10	8	15	11
12.01–2 p.m.	3	22	8	8	15	11
2.01–4.30 p.m.	7	7	19	13	16	21
4.31–6.30 p.m.	36	12	11	24	14	13
6.31–10 p.m.	5	8	22	9	13	27
After 10 p.m.	2	5	17	3	5	10
Total	100	100	100	100	100	100

Source: London Travel Survey data.

The following points may be noted:

(*a*) The concentration of traffic in the familiar morning and evening peaks on Mondays to Fridays (the figures relate to traffic in both directions, so that the full magnitude of the uni-directional morning and evening peaks is not revealed);

(*b*) the greater concentration of traffic on the railways during the peak periods;

(*c*) the different distribution of traffic on Saturdays compared with other week-days, emphasized since the war by the widespread adoption of the five-day week;

(*d*) the slower build-up of traffic on Sundays compared with Saturdays.

51. Anybody who has to travel to and from work during the rush hours is familiar with the problem of the peak traffic. Together with the high cost of constructing tube railways, it conditions the economics of the local transport of Londoners; the resources of equipment and the services provided are governed primarily by the demands of the rush hours. The root of the matter, of course, lies in the conventional times of starting and finishing work, as shown by the figures in Table 21, obtained from the Travel Survey.

The fondness of human nature for rounded figures is aptly illustrated by the piling up that occurs towards 8 and 9 in the morning and towards 5, 5.30 and 6 in the evening. Here is the origin of the "problem of the peaks", which afflicts passenger transport operators the world over.

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TABLE 21.—*London Transport Area. Times of Starting and Finishing Work*

Starting Work		*Finishing Work*	
Time a.m.	*All workers %*	*Time p.m.*	*All workers %*
Up to 7.15	9	1.00–4.15	9
7.16–7.45	9	4.16–4.30	4
7.46–8.00	29	4.31–4.45	1
8.01–8.15	1	4.46–5.00	24
8.16–8.30	7	5.01–5.15	2
8.31–8.45	1	5.16–5.30	23
8.46–9.00	22	5.31–5.45	2
9.01–9.30	6	5.46–6.00	16
9.31–12.00	4	6.01–8.00	5
Other times	12	Other times	14
Total	100	Total	100

52. The impact upon the transport agencies of these social habits in regard to hours of work will be obvious. It is true that not all workers use public means of transport; the proportion travelling by public transport, according to the Travel Survey, is 58 per cent. in Greater London. Nor do all of these require transport into the central area. There is, in fact, a separate peak problem in the factory districts in the outer parts of London which primarily concerns the road services. To those working in the central area, however, the most familiar aspect of rush-hour travel is provided by the railways. Inward and outward traffic flows, pre-war and post-war, during the hours of greatest congestion on London Transport railways are shown in Table 22. The figures for ten-minute intervals are also shown in the graphs in Appendix C.

TABLE 22.—*London Transport Railways. Traffic Flow into and out of Central Area Winter*, 1936–37 *and Winter*, 1947–48

Number of Passengers

Inflow			*Outflow*		
Time a.m.	1936–37	1947–48	*Time p.m.*	1936–37	1947–48
7.00½–7.30	39,030	39,260	4.30½–5.00	25,770	46,520
7.30½–8.00	69,460	70,030	5.00½–5.10	14,300	27,800
			5.10½–5.20	17,670	32,120
8.00½–8.10	14,030	18,150	5.20½–5.30	22,300	31,120
8.10½–8.20	16,100	19,200			
8.20½–8.30	19,310	24,040	5.30½–5.40	19,920	34,340
			5.40½–5.50	22,920	33,340
8.30½–8.40	27,780	33,250	5.50½–6.00	25,780	39,720
8.40½–8.50	34,780	36,560			
8.50½–9.00	38,390	35,700	6.00½–6.10	24,490	34,700
			6.10½–6.20	30,020	26,970
9.00½–9.10	28,620	33,960	6.20½–6.30	31,920	24,150
9.10½–9.20	30,010	24,770			
9.20½–9.30	24,570	26,030	6.30½–7.00	69,770	40,210
9.30½–10.00	49,920	44,520	7.00½–7.30	42,270	26,010

Note.—For the purposes of the above table, the "central area" is taken to be, approximately, an area bounded by the main line terminal stations.

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The following points will be apparent from a scrutiny of the table and the graphs:

(*a*) The first peak prior to 8 a.m. due to workmen's traffic, followed by a second business peak just before 9 a.m.;

(*b*) the comparative stability of the morning pattern of movement into the central area compared with before the war;

(*c*) the combination of the workmen's and business traffic in the evening peak, and the greater concentration of traffic under post-war conditions between the hours of 5 and 6 p.m.;

(*d*) the earlier incidence of the evening peak nowadays—about half an hour earlier than before the war.

(*c*) and (*d*) of course arise from the shortening of the working day and the closer assimilation of the working hours of all classes.

53. The importance, in terms of the volume of travel, of the suburban, and especially the outer suburban, services of the Railway Executive has already been noted. It is interesting, therefore, to compare up-to-date figures of the passengers arriving at the main line termini before 10.30 a.m. with those quoted in Sir Edgar Harper's paper. The Railway Executive has been good enough to furnish the necessary information, which is summarized for terminals in the City and West End respectively in Table 23. The figures for 1949 are not strictly comparable with those for 1903, since they include passengers arriving on long-distance trains from the coast and elsewhere. With the improvement in the services to coastal resorts and to other towns, the

TABLE 23.—*Railway Executive. Number of Passengers Arriving before* 10.30 *a.m. at City and West End Termini*

(*Thousands*)

	Before 7 *a.m.*	7 *to* 8 *a.m.*	8 *to* 9 *a.m.*	9 *to* 10 *a.m.*	10 *to* 10.30 *a.m.*	*Total*	*Per cent. of total Central Area traffic*
City—							
1903	29·2	43·6	73·0	68·0	17·8	231·6	73
	(13)	(19)	(31)	(29)	(8)	(100)	
1949	8·3	40·1	73·2	55·6	5·6	182·8	49
	(5)	(22)	(40)	(30)	(3)	(100)	
Increase or Decrease	(−)20·9	(−) 3·5	(+)0· 2	(−) 12·4	(−) 12·2	(−) 48·8	..
Per cent.	(−)72	(−) 8	(+)0·3	(−) 18	(−) 69	(−) 21	
West End—							
1903	8·9	10·2	28·0	31·3	8·6	87.0	27
	(10)	(12)	(32)	(36)	(10)	(100)	
1949	6·8	36·0	83·7	55·9	9·5	191·9	51
	(3)	(19)	(44)	(29)	(5)	(100)	
Increase or Decrease	(−) 2·1	25·8	(+) 55·7	(+) 24·6	(+) 0·9	(+)104·9	
Per cent.	(−)24	253	(+)199	(+) 79	(+) 10	(+)121	
Total—							
1903	38·1	53·8	101·0	99·3	26·4	318·6	100
	(12)	(17)	(32)	(31)	(8)	(100)	
1949	15·1	76·1	156·9	111·5	15·1	374·7	100
	(4)	(20)	(42)	(30)	(4)	(100)	
Increase or Decrease	(−)23·0	(+)22·3	(+) 55·9	(+) 12·2	(−) 11·3	(+) 56·1	
Per cent.	(−)60	(+)41	(+) 55	(+) 12	(−) 43	(+) 18	

Note.—The number of passengers arriving at King's Cross and St. Pancras has been apportioned equally between the City and West End.

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number of business people using the long-distance services has, as already pointed out, grown appreciably of recent years.

Since 1903, the total number of passengers arriving at the main line termini up to 10.30 a.m. has increased by 18 per cent., but the increase at the West End termini has been 121 per cent. compared with a decrease of 21 per cent. at the City termini. In fact, the proportion of those main line passengers having the West End as their objective has increased from one-quarter to one-half since 1903. This trend was already in evidence before the war and was associated *inter alia* with the growing commercial importance of the West End. It has been accentuated by the widespread destruction during the war of office accommodation in the City, and has given rise to new traffic problems, particularly as regards the peak traffics on the Central Road Services of London Transport. The reconstruction of the City is urgent, if a balance between City and West End is to be restored.

54. The growing concentration of traffics at such termini as Charing Cross and Euston gives rise to problems of their dispersal to destinations over the central area. The schemes of railway development devised by the London Plan Working Party aim *inter alia* at transferring portions of this traffic to tubes having direct access to the central area, thereby avoiding the necessity for changing at the main line termini on to the already crowded existing tube system. The need for tube facilities from Victoria to the West End, to which the Royal Commission on London Traffic drew attention, is also met.

55. It will be obvious that, with such concentrations of traffic within comparatively short periods, standing in trains must be accepted as part of the price of living and working in or near a great city. As already noted, the Royal Commission on London Traffic was greatly concerned, nearly 50 years ago, with the problem of congestion on both rail and road services. In course of time large-scale relief will result from the construction of the new tube railways recommended in the Report of the London Plan Working Party. Meanwhile, the only possible palliative lies in the "staggering" of hours of work. An account of the active steps that have been taken to bring about adjustments of working hours in order to even out the peak loadings will be found in the last three Annual Reports of the London Passenger Transport Board for 1945, 1946, and 1947, and in the first Annual Report of the British Transport Commission. The extent of the problem is set out quite simply in the following passage from the thirteenth Annual Report of the London Passenger Transport Board, for the year 1946:—

> "If, for example, the whole of the underground railway traffic leaving Central London between 4.30 p.m. and 6.30 p.m. could be evenly spread over the period, the peak demand for railway transport at the period of maximum congestion would be reduced by some 40 per cent. On all forms of transport, it is estimated that nearly 600,000 people leave the centre of London on their homeward journey between 5 p.m. and 6 p.m. in the evening, a number which strains to the utmost limit the total transport capacity which can be made available in that hour. Yet no radical change in commercial practice or social habits would be required to achieve substantial relief; for an alteration, frequently of only a quarter of an hour, in the starting and finishing times of work, applying to, say, a quarter of the traffic, is all that would be necessary."

56. In the industrial areas outside central London, the co-operation has been enlisted of the Industrial Local Transport Groups—a voluntary movement which was initiated during the war by the London and South-Eastern Regional Board for Industry. The diagrams in Appendix "D" show the changes that have taken place every two years, since 1944, in the hours of work of some half a million employees in 1,100 firms covered by 50 of the Groups. It will be seen that, under war-time conditions, considerable success was achieved, in 1944, in spreading the hours of starting and finishing work, so relieving the pressure on the over-strained transport facilities. Under post-war conditions, however, while there was, at first, a reduction in the numbers employed, there was also curtailment of overtime and, later, the adoption of the 44-hour week. There is the further factor that there are now, in 1950, more people employed by the 1,100 firms than in 1944. The result has been added congestion, particularly in the evening peak period, when some 30,000 more workers have to be moved. Nevertheless, but for the efforts of the Local Transport Groups the position would have been worse. The spreading, to a quite moderate extent, of peak hour travel still remains a major problem of local passenger transport in the London area.

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Daily Incidence of Traffics

57. Table 20 shows how the distribution of regular journeys by hours of the day varies over the week. As would be expected, the Monday to Friday, Saturday, and Sunday patterns differ markedly, with corresponding problems for the operators in the adjustment of services. Table 24 gives, by forms of transport, the percentage distributions over the week of the takings of London Transport in 1938–39 and in 1948.

TABLE 24.—*All Services: London Transport Executive. Percentage Distribution of Takings Over the Week*

1948 *compared with* 1938–39

(*The average daily figure for Monday to Friday is shown in Italics*)

	Year	Mondays to Fridays	Saturdays	Sundays	Total
Railways	1938–39	77 (*15*)	16	7	100
	1948	76 (*15*)	16	8	100
Central Buses	1938–39	71 (*14*)	18	11	100
	1948	72 (*14*)	17	11	100
Trams and Trolleybuses	1938–39	72 (*14*)	18	10	100
	1948	72 (*14*)	18	10	100
Country Buses	1938–39	65 (*13*)	22	13	100
	1948	69 (*14*)	20	11	100
Coaches	1938–39	61 (*12*)	22	17	100
	1948	64 (*13*)	19	17	100
Total	1938–39	72 (*14*)	18	10	100
	1948	73 (*15*)	17	10	100

The heaviest traffics are on Saturdays, although, according to the Travel Survey, the proportion of journeys by Greater London residents to and from work falls to 48 per cent. of all regular journeys, compared with 70 per cent. on Mondays to Fridays (see Table 26).

The pre-war and post-war distributions exhibit a considerable degree of stability, although on the Country Buses and Coaches a higher proportion of the traffic is now carried on Mondays to Fridays than before the war. This must be related to the outward movement of population since 1939, to which attention has already been directed, and the growth of industrial and commercial activities outside Greater London.

The use of takings gives distributions which allow for both the number and length of journeys by passengers on each form of transport. The distributions by reference to passenger journeys exhibit the same general features as those by reference to takings.

Seasonal Trend of Traffics

58. As the result of the dislocation caused by the war, it was not until the beginning of 1948 that post-war traffics became more or less stabilized, at a level which has remained substantially above that prevailing before the war. The years 1948 and 1949, however, form too short a period for a study of seasonal movements in post-war traffics, quite apart from the fact that, because of petrol rationing and other factors, traffics in those years can hardly be regarded as normal in the pre-war sense. It is, however, possible to compare the movements of London Transport traffic takings in successive four-weekly periods in 1948 and 1949 with the results of a study of seasonal movements made before the war.

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59. The estimates of the pre-war seasonal movements were derived from an analysis of London Transport takings in four-weekly periods over the period from 1933–37. A moving geometric mean was calculated of the takings for groups of 13 four-weekly periods, and the actual takings for each four-weekly period were expressed as a percentage of the mean so obtained; the percentages for the corresponding four-weekly periods in each year were then averaged, with the results shown in Table 25.

TABLE 25.—*All Services: London Transport Executive. Average Variation from Moving Geometric Mean of Takings in the Years* 1933–37 *by Four-weekly Periods*

Four-week period (starting January)	*Railways* %	*Central Road Services (Central Buses, Trams and Trolleybuses)* %	*Country Buses and Coaches* %
1	104·5	98·1	99·8
2	102·9	96·0	89·1
3	103·5	96·1	89·9
4	102·2	99·4	93·7
5	102·4	101·9	96·7
6	99·9	104·2	101·6
7	99·2	103·5	105·6
8	95·4	102·0	105·9
9	88·0	98·3	117·6
10	92·8	100·2	112·0
11	101·6	102·2	103·1
12	104·8	100·2	97·5
13	106·7	98·4	91·6

60. The pre-war traffics exhibited the following seasonal features—

(*a*) On the railways, the traffics built up to a peak in December; they fell off gradually from January until the end of Spring, and were at their lowest during the holiday months of August and September.

(*b*) On the Central Road Services, the traffic peaks, as might be expected, were during May and June, followed by a falling off during the conventional holiday period; the lowest point was reached during the period mid-January to mid-March.

(*c*) On the Country Buses and Coaches, traffics were at their peak during the holiday period, with a heavy falling off during the Winter months, more pronounced than in the case of the Central Road Services.

61. In Graph 1 on page 324 the actual London Transport takings in successive four-weekly periods of 1948 and 1949, expressed as a percentage of the average of the takings over each of the two years, are compared with the pre-war seasonal patterns shown by the percentages in Table 25.

It will be seen that—

(*a*) Railway takings are now much less subject to seasonal movement than before the war. The absence of deep troughs in the holiday months of August and September will be particularly noted; this may be due *inter alia* to the effects of the extension of holidays with pay, which has the double effect of permitting Londoners to travel while spending their holidays at home, as many of them do, and enabling people living elsewhere to visit London.

(*b*) As regards road services, the seasonal pattern of takings is much the same now as it was before the war.

VII. THE REASONS FOR TRAVEL AND THE JOURNEY TO WORK

62. While the operator of public transport services is sufficiently aware of the existence of a daily demand for facilities to get to and from work, and of the special demands in connection

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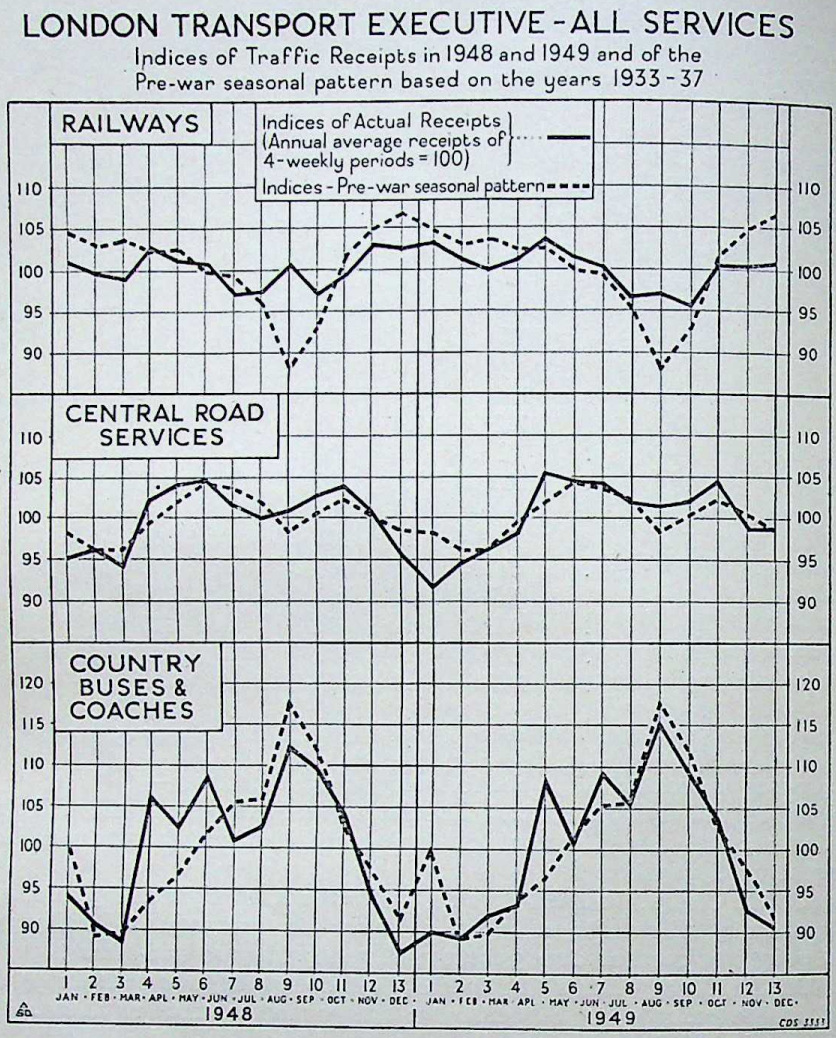
GRAPH 1



with sporting and other public events, a detailed knowledge of why people travel and in what proportions does not flow from the day-to-day administration of transport undertakings. Such information is, of course, of great interest and value in any study of the social aspects of transport, and it was not until the London Travel Survey was carried out that any systematic data became available. The main section of the Travel Survey was based on interviews with the members of 2,695 households who gave particulars about their "regular" journeys in the London Transport Area. These households were within an area slightly larger than that of Greater London. Members of households in three selected country towns in the outer parts of the area were also interviewed. As already explained, for purposes of the Survey, "regular" travel was defined in wide terms so as to include even a journey once a week, provided it was made regularly and for a specific purpose. On this basis it was estimated that about two-thirds of all journeys, both regular and casual, were covered. The data have been analysed in considerable detail in respect of sex; age group; status (workers of all classes, housewives, scholars and unoccupied); income group (over £650 p.a., £8–£13 p.w., £4–10–0–£8 p.w., under £4–10–0 p.w.); and purpose. It is possible here to indicate only a few of the highlights revealed by the Survey; those desirous of further details should refer to *London Travel Survey: 1949*, recently published by the London Transport Executive, which also gives an account of the sampling methods employed.

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63. The following table shows the distribution of regular journeys, according to purpose, on London Transport Railways, Central Buses, Trams and Trolleybuses, and for these services together by days of the week.

TABLE 26.—*London Transport Executive: Railways and Central Road Services. Distribution of Regular Journeys According to Purpose*

	Form of transport				*Day*			
Purpose	*Railways* %	*Central Buses* %	*Trams* %	*Trolleybuses* %	*Mondays to Fridays* %	*Saturdays* %	*Sundays* %	*Total* %
Work	84	59	67	64	70	48	16	66
School	6	10	7	7	10	1	—*	8
Shopping	2	12	8	10	8	17	1	9
Theatre/Cinema	2	7	6	7	5	14	12	6
Sports	1	2	3	3	1	8	6	2
Other	5	10	9	9	6	12	65	9
Total	100	100	100	100	100	100	100	100

* Represents less than 0·5 per cent.

The following points will be noted—

(*a*) The proportion of regular passengers on the railways who are travelling to and from work is relatively higher than on Central Buses, Trolleybuses or Trams.

(*b*) The proportion of workers to all regular travellers falls from 70 per cent. on Mondays to Fridays to 48 per cent. on Saturdays and 16 per cent. on Sundays.

(*c*) Sixty-five per cent. of the traffic on Sundays travels for "other purposes", comprising outings to the country, social visits and other journeys of a similar nature.

64. Table 27 shows how regular journeys for each purpose are spread over London Transport Railways, Central buses, Trams and Trolleybuses.

TABLE 27.—*London Transport Executive: Railways and Central Road Services. Distribution over the Forms of Transport of Regular Journeys According to Purpose*

Purpose	*Railways* %	*Central Buses* %	*Trams* %	*Trolleybuses* %	*Total* %
Work	28	46	7	19	100
School	14	62	7	17	100
Shopping	5	67	7	21	100
Theatre/Cinema	8	63	7	22	100
Sports	13	50	11	26	100
Other	12	59	8	21	100

65. The journey to and from work is, of course, the mainstay of all local transport services; the figures quoted in Table 26 afford a measure of its predominance. The Travel Survey also shows that 58 per cent. of all workers in Greater London use public transport services in getting to and from their work, 17 per cent. go on foot, and 14 per cent. use a bicycle. Of the remainder, 6 per cent. use a car or other means of transport, and 5 per cent. work at home.

66. It was possible to obtain from the Survey an analysis of the reasons why workers do not use public transport in travelling to and from their work, apart from those who work at home. These are shown in Table 28, together with the alternative means of transport employed. Because many workers have more than one reason for not using public transport, the first column adds up to more than 100.

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TABLE 28.—*Greater London. Workers' Reasons for Using Other Means of Transport for Travelling To and From Work*

Reasons	Workers	Alternative Means Employed					
		Foot	Cycle	Motor cycle	Car	Other	Total
	%	%	%	%	%	%	%
Nearness	50	62	11	—*	1	26†	100
Quickness	26	12	59	7	20	2	100
No convenient public transport	17	23	59	3	13	2	100
Economy	11	4	83	8	4	1	100
Hobby	4	20	71	6	2	1	100
Health	3	26	46	5	23	—	100
Other	12	37	24	2	25	12	100
	123	40	32	3	10	15	100

* Represents less than 0·5 per cent.
† Includes 25 per cent. who work at home.

It will be observed that "no convenient public transport" and "economy" are third (17 per cent.) and fourth (11 per cent.) respectively in the order of importance of the reasons why public transport is not used by workers. Nearly three-quarters of those workers who do not use public transport for travelling to and from work go on foot or use a bicycle.

67. The length of the journey to work is a factor of great social importance to which the Barlow Commission directed attention, and it is now one of the principal aims of planning policy to reduce the time so spent in travel by a closer association of home and workplace. The Travel Survey shows that workers using public transport for the journey to work in Greater London take an average of 42 minutes from door to door. Of these workers, some 30 per cent. spend less than half-an-hour, and about 50 per cent. between half-an-hour and an hour. The remaining 20 per cent. take over an hour to do the journey from home to workplace, but about half of them do it in not more than 70 minutes. The actual time spent in travel by public transport is, of course, somewhat less. Homes in Greater London are, on the average, nearly 4 minutes from the nearest form of public transport, whilst the worker is set down, on the average, within 5 minutes' walk of his place of work. Bearing in mind that the worker does not necessarily use the form of transport nearest to his home, the average time spent in actual travel by public transport by the Greater London worker on the journey to work may be put at about half-an-hour.

68. The average time spent on each vehicle in the course of a "ride", as opposed to the complete "journey" from the point of view of the passenger, is of course less. As already stated, only 56 per cent. of workers complete the journey to work by public transport without changing. The Travel Survey shows that the inhabitants of Greater London, in the course of regular journeys of all kinds, within the Survey area, including those to work, spend on the average 12 minutes per journey on the Central bus, 13 minutes on the tram or trolleybus, 18 minutes on the London Transport train, and 20 minutes on the Railway Executive suburban train.

VIII. EXPENDITURE ON TRAVEL

69. A study of published financial results would open up for discussion a wide range of matters, including fares policy, which could hardly be satisfactorily disposed of without an inordinate expansion of an already over-long paper. But in any broad account of London's local transport system, some indication of the level of expenditure on travel, and of its incidence, can hardly be avoided. Until the Travel Survey was undertaken no reliable data were available about either the total household expenditure on regular travel, or the cost to the individual worker of getting to and from his job.

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70. Table 29 shows the total passenger takings of London Transport, and takings from journeys within the London Transport Area on the suburban railway services of the Railway Executive. Average takings per head of the population are also shown:

TABLE 29.—*London Transport Area. Passenger Takings in Total and Per Head of Population*

Year	Population (000)	Passenger Takings: London Transport (£000)	Passenger Takings: Suburban Services of Railway Executive (£000)	Passenger Takings: Total (£000)	Per Head of Population: London Transport £	Per Head of Population: Suburban Services of Railway Executive £	Per Head of Population: Total £
1933–34	9,386	28,240	10,531	38,771	3·0	1·1	4·1
1938–39	9,859	30,512	11,946	42,458	3·1	1·2	4·3
1948	9,620	56,988	18,134	75,122	5·9	1·9	7·8
1949	9,751	56,199	17,704	73,903	5·8	1·8	7·6

The figures of takings per head of population are, of course, no more than crude indications of the level of expenditure on travel by the London resident. Passenger takings also include takings from the large number of visitors to London, both from home and overseas. The figures of rides and passenger miles per head of population quoted earlier are subject to similar qualifications.

71. The substantial increase in takings since before the war is due not only to the great increase in travel that has taken place, but also to increases in fares. The analysis in Table 30 of pre-war and post-war takings from London Transport rail and road services shows the relative proportions of the increases attributable to higher fares, to the larger number of journeys, and to the longer average distance travelled.

TABLE 30.—*London Transport Executive. Analysis of Percentage Increases in Actual Takings:* 1948 *compared with* 1938–39

	Increase per cent.			
	Mondays to Fridays	*Saturdays*	*Sundays*	*Total*
Passenger Journeys	21	17	22	20
Takings per Passenger Journey	16	16	15	16
Takings (at 1938–39 fare levels)	40	36	41	39
Fares Increases	33	33	33	33
Actual Takings	87	81	88	86

Thus, in 1948 compared with before the war, passengers spent 20 per cent. more because they travelled more frequently, 16 per cent. more because they travelled further, and 33 per cent. more because fares were higher.

72. These total figures, however, afford little indication of the significance of the cost of travel, whether to the typical household or to the typical worker. The figures of weekly expenditure for regular journeys by public transport averaged over all households in Greater London were obtained from the Travel Survey and are shown in Table 31. Separate figures are given for the average weekly household expenditure on all regular journeys, and on journeys to and from work by workers of all classes in the household.

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TABLE 31.—*Greater London. Weekly Expenditure on Regular Travel by Public Transport Averaged over All Households*

Area	All Regular Journeys		Journeys to and from Work	
	Average Weekly Expenditure by All Households	Proportion of Households with No Expenditure on Travel	Average Weekly Expenditure by All Households	Proportion of Households with No Expenditure on Travel to Work
County of London	*s. d.*	%	*s. d.*	%
North	3 8	25	2 10	44
South	4 7	19	3 6	43
Suburban	5 6	22	4 4	45
Greater London	5 0	22	3 10	44

In 22 per cent. of households in Greater London there is no member making regular journeys of any kind on public transport, whilst the proportion of households with no member using public transport for travel to and from work is 44 per cent.

73. In the 78 per cent. of households having at least one member using public transport regularly, the average weekly expenditure for all regular journeys is 6*s.* 5*d.*, but 50 per cent. of these households spend 4*s.* 6*d.* or less.

74. In view of the obligatory character of the journey to and from work, it is of particular interest to know the average weekly cost of this journey to workers using public transport, who number 58 per cent. of all workers (see paragraph 65). Table 32 shows figures obtained from the Travel Survey.

TABLE 32.—*Greater London. Weekly Expenditure of Workers of All Classes on the Journey To and From Work by Public Transport*

Area	Average Expenditure per Worker	Expenditure of "median" Worker
County of London	*s. d.*	*s. d.*
North	3 7	3 0
South	4 2	3 6
Suburban	5 6	4 6
Greater London	4 10	3 9

For men workers in Greater London the average weekly expenditure in getting to and from work is 5*s.* 2*d.*, and for women workers 4*s.* 3*d.*

75. The distribution of the weekly travel costs of the worker is, however, wide and uneven, as will be seen from Graph 2 on page 329.

In these circumstances the use of an average figure of expenditure per worker can be misleading, because it is not typical of that of the majority of workers concerned. A better reflection of the expenditure of the worker on travel to and from work is that of the "median" worker which is shown in Table 32. Thus, 50 per cent. of all workers in Greater London using public transport to get to work spend less than 3*s.* 9*d.* per week, the figure for men being 4*s.* 3*d.* and for women 3*s.* 3*d.* A cumulative distribution of expenditure by such workers, from which the estimate of 50 per cent. is derived, is shown in Table 33.

76. There are no official post-war figures of the average weekly expenditure of households of the types which form the basis of the Ministry of Labour's 1937–38 Survey of Expenditure of Industrial Working Class Households. An unofficial estimate, relating to approximately

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GRAPH 2

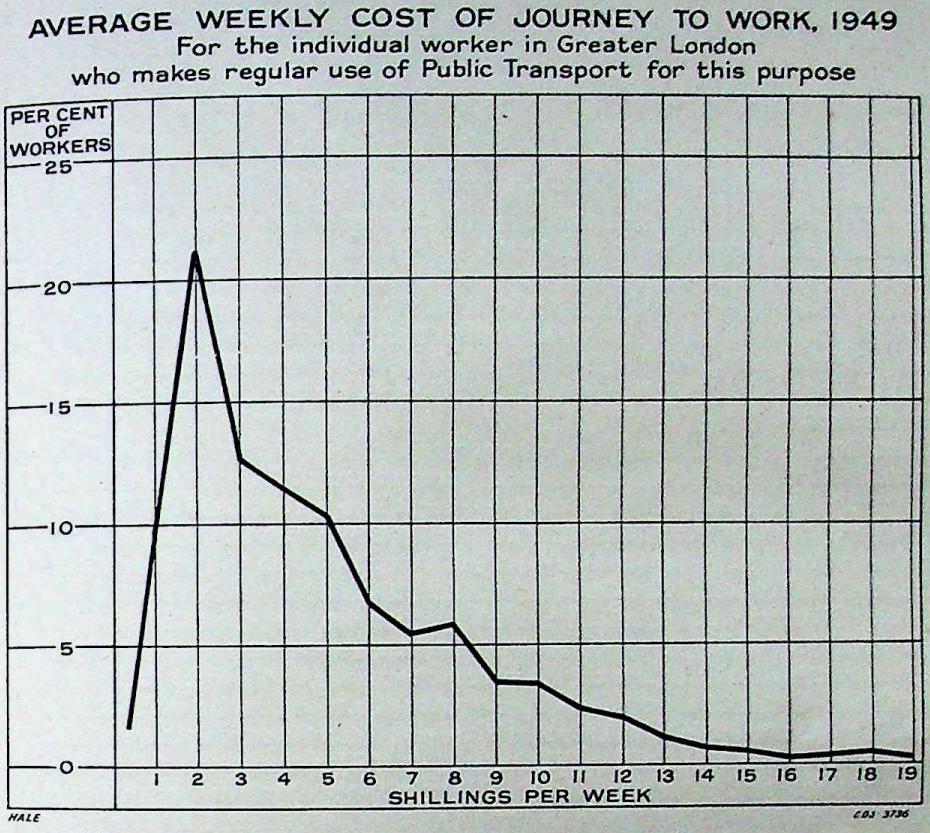

TABLE 33.—*Greater London. Distribution of Weekly Expenditure by Workers Using Public Transport for Journeys to and from Work*

Amount per Week	*Workers Using Public Transport*	
	Proportion %	*Cumulative Proportion* %
1*d.*– 6*d.*	0·8	0·8
7*d.*– 1*s.* 5*d.*	8·9	9·7
1*s.* 6*d.*– 2*s.* 6*d.*	23·0	32·7
2*s.* 7*d.*– 3*s.* 5*d.*	11·6	44·3
3*s.* 6*d.*– 4*s.* 6*d.*	12·4	56·7
4*s.* 7*d.*– 6*s.* 6*d.*	16·7	73·4
6*s.* 7*d.*– 8*s.* 6*d.*	11·2	84·6
8*s.* 7*d.*–10*s.* 6*d.*	6·7	91·3
10*s.* 7*d.* and over	8·7	100·0
	100·0	

the first quarter of 1948, puts the figure at 170*s.* per week (British Standards of Living, by Dr. Mark Abrams: Bureau of Current Affairs, September 1948). There has been some increase since then, and it would appear that expenditure on the journey to work represents, on the average, about 2½ per cent. of the weekly expenditure of industrial working-class households in Greater London.

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77. The Travel Survey showed that the average expenditure per worker of all classes in Greater London who uses public transport to get to work is 4*s.* 10*d.* per week. There are no published figures of average earnings of industrial workers in London. But, taking as a guide the national figure for the major industries, shown by the Ministry of Labour earnings census of April 1949, namely, 119*s.* 4*d.* per week, the cost to the individual worker in Greater London of the journey to and from work averages under 4 per cent. of his weekly earnings.

IX. Use of Statistical Methods at London Transport

78. The practitioner in advanced statistics, if he has read so far, may well find this lengthy account of London's transport system and the travel habits of Londoners unsatisfying and perhaps even jejune. What has happened, he may ask, to the modern critical apparatus of mathematical statistics? To this enquiry two replies are offered: first, the Society has a long tradition of accepting statistical accounts, in the old-fashioned sense, of particular activities, and one about London and its transport system seemed to be overdue; secondly, at London Transport, modern statistical techniques were, in fact, employed even in pre-war days, and are being employed in increasing measure to-day.

79. Thus, familiar statistical methods have long been freely applied in investigations, especially on the road engineering side. Examples are: measurement of influence on fuel consumption of such factors as weather, passenger loadings, daily mileage operated, technical variations in the fuel injector, use of thermostatic control; examination of area differences in frequency of trolley-pole "dewirements"; application of life-table technique to estimation of life of diesel engines; use of control chart principle in evaluating significance of weekly fluctuations in numbers of engineering failures; and the selection of samples for various purposes.

80. No references to the employment of statistical methods would be complete nowadays without mention of operational research. It is many years since an observer was first sent out with a stop-watch to collect data about the delays on typical bus routes in the central area due to the presence of horse-drawn vehicles on the streets. Again, by mathematical analyses of the characteristics of systems of automatic signalling and of the rolling stock, particularly in respect of acceleration and braking, it was found possible, before the advent of "operational research", to establish the maximum rate at which trains can be got through a given section of line, and the operating conditions to be satisfied. If one purpose of operational research is the better utilization of equipment under service conditions, this study should rank as such, although the mathematical analysis did not employ statistical techniques; but such techniques will almost certainly be needed in the detailed studies of factors such as passenger flow, affecting station design, and train loadings, affecting the internal lay-out and door arrangements on rolling stock, which are now being undertaken in connection with the practical application of the results of this study. In various researches, notably into the examination of factors influencing design of road vehicles, familiar statistical methods are, of course, freely employed.

X. Conclusion

81. The outstanding feature of local travel in the London Transport Area is the insatiable demand for more and better transport facilities. The period of nearly half a century that has elapsed since Sir Edgar Harper read his paper and the Royal Commission on London Traffic reported has seen great developments. The ever-growing needs of the community stimulated strenuous, if not always co-ordinated, efforts on the part of the competitive private undertakings which, until 1933, were mainly responsible for the provision of transport facilities. Up to World War II, the development of London itself proceeded with little or no central guidance. The idea that housing development should march in step with factory development, let alone with development of the requisite passenger transport facilities, had not gained governmental acceptance. To-day the practical application of planning principles is still hampered by the multiplicity of authorities concerned. It may fairly be claimed that the Underground Group were pioneers in the field of transport planning, although this only became fully effective after the formation of the London Passenger Transport Board. Even to-day there is not always adequate realization

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of the need to associate civic and transport developments, so that waste of existing facilities may be avoided. In this connection the economic truism must never be forgotten that building a railway, particularly underground, is a costly business. It represents, moreover, a long-term commitment which, once entered into, cannot soon be abandoned without an intolerable waste of social effort. The advantages of road transport in this respect are obvious.

82. It has been shown that, in terms of car miles, the volume of services provided by London Transport has generally increased faster than the population, but the very considerable expansion of all services, both rail and road, over the last 50 years has still not kept pace with the ever-growing urge to travel. New facilities themselves invariably generate yet further travel. All the time there has been the outward shift of population from the centre, and a growing separation of home from workplace which it is a major purpose of town and country planning to counteract. To relieve existing overcrowding on the services and to provide for present as well as future needs, as far as they can be foreseen, the London Plan Working Party has prepared a master plan involving the construction of many miles of new tube railways and the electrification of long stretches of the outer suburban railways north of the River. The cost of these railway works has been put at a figure approaching £350 millions; this is quite apart from the development of the system of road services which the wider dispersal of population from the centre must inevitably entail. It will have been seen that basic factors in the provision of local transport for a metropolis such as London are the uneconomic character of deep-level tube railways, and the problem of providing for the peak traffics. These over-riding considerations will be no less dominant in any major plan of railway development.

83. It is to be hoped that the acceptance as a matter of government policy of the principles of town and country planning embodied in the County of London and Greater London Plans will in future lead to better co-ordination of all social and economic development than was possible in the past. It has at times been suggested that the transport undertakings, and London Transport and the former Southern Railway Company in particular, are almost to blame for rendering possible, by railway extensions and electrification, the spread of London which gave rise to such anxiety before World War II. Nobody will dispute the desirability of the ideal of a closer association of home and workplace in order that the strain and expense of daily travel to and from work may be minimized. Nevertheless, human nature being what it is, the lure of the metropolis will always be there and, if transport facilities to and from the centre are required to meet business and social needs, it is the duty of the transport undertakings to provide them.

84. No discussion on transport in London would be complete without a reference to the familiar problem of traffic congestion, with its obvious repercussions on the speed and regularity of the public road services. Traffic congestion is assuming alarming proportions in central London. There has been a marked growth in the number of lorries operating in that area and the parking of private cars in the streets has also been a major cause of congestion. "No Waiting" and other traffic restrictions have achieved a degree of success but can, at best, be only palliatives. Sooner or later drastic action will be necessary to prevent movement in London being brought to a virtual standstill, as has already happened in some American cities. Whatever measures may be taken, the fullest scope must continue to be accorded to the bus, upon which the great mass of the travelling public are dependent for access to important objectives: there should be no discrimination against the bus in favour of the private car.

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85. It remains to acknowledge warmly the valuable assistance and co-operation that have been received from the writer's colleagues and, in particular, Mr. C. R. Grant, in the assembly of the statistical material embodied in this paper. Appreciation is also due to the Ministry of Labour for making available raw material, on the basis of which Table 8 showing the distribution of factories over the London Transport Area has been prepared, and to the Railway Executive for the up-to-date information they have been good enough to supply of route mileage and stations, and the numbers of trains and of passengers arriving at main line termini. The material derived from the London Travel Survey has been used with the permission of the London Transport Executive, as well as certain figures which have not previously been published. Much of the remaining material, however, has been derived from the publications to which reference is made in the Bibliography.

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APPENDIX A.—*London Transport Area. Analysis of Changes in the Distribution of the Total Population*
(*Thousands*)

	Natural Increase					Net Migration: Gain (+) or Loss (−)							
	County of London (1)	*Outer Ring* (2)	*Greater London* (3)	*Outer country area* (4)	*London Transport Area* (5)	*County of London* (6)	*Outer Ring* (7)	*Greater London* (8)	*Outer country area* (9)	*London Transport Area* (10)	*Greater London Total Increase (+) or Decrease (−)* (11)	*Outer country area Increase (+) or Decrease (−)* (12)	*London Transport Area. Total Increase (+) or Decrease (−)* (13)
Census date to Census date—													
1891–1901	491	239	730	..	..	(−) 183	(+) 400	(+) 217	..	..	(+) 947	..	..
1901–11	539	363	902	..	..	(−) 553	(+) 321	(−) 232	..	..	(+) 670	..	..
1911–21	360	296	656	..	..	(−) 397	(−) 30	(−) 427	..	..	(+) 229	..	..
Mid-year to mid-year—													
1921–26	161	122	283	20	303	(−) 54	(+) 64	(+) 10	(+) 36	(+) 46	(+) 293	(+) 56	(+) 349
1926–33	94	134	228	35	263	(−) 426	(+) 729	(+) 303	(+) 133	(+) 436	(+) 531	(+) 168	(+) 699
1933–37	21	82	103	19	122	(−) 226	(+) 418	(+) 192	(+) 88	(+) 280	(+) 295	(+) 107	(+) 402
1937–39	13	50	63	12	75	(−) 94	(+) 104	(+) 10	(+) 43	(+) 53	(+) 73	(+) 55	(+) 128
1939–44*	(−)2	116	114	32	146	(−) 1,794	(−) 1,110	(−) 2,904	(+) 17	(−) 2,887	(−) 2,790	(+) 49	(−) 2,741
*1944–45	1	16	17	5	22	(+) 383	(+) 447	(+) 830	(−) 23	(+) 807	(+) 847	(−) 18	(+) 829
1945–49	98	156	254	42	296	(+) 691	(+) 661	(+) 1,352	(+) 127	(+) 1,479	(+) 1,606	(+) 169	(+) 1,775

* September.

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APPENDIX B.—*Major Railway Developments Affecting the London Transport Area since* 1902

1902–18

LONDON TRANSPORT

1903	Metropolitan District (Section now part of Piccadilly Line)	Ealing Common to South Harrow Extension opened.
1904	Great Northern and City (now part of Northern Line)	Finsbury Park to Moorgate opened.
1904	Metropolitan	Harrow-on-the-Hill to Uxbridge Extension opened.
1905	Metropolitan District (now District Line)	Electrification of all Steam Lines.
1905	Metropolitan	Electrification of all Lines (except Harrow to Rickmansworth).
1906	Great Northern, Piccadilly and Brompton (now Piccadilly Line)	Hammersmith to Finsbury Park opened.
1906	Hammersmith and City	Line electrified.
1906–07	Baker Street and Waterloo (now Bakerloo Line)	Elephant and Castle to Edgware Road opened.
1907	Charing Cross, Euston and Hampstead (now Northern Line)	Strand to Golders Green and Highgate opened.
1908	Metropolitan District (now District Line)	Electric services extended to Barking over London, Tilbury and Southend Railway tracks.
1913	East London	Electrified and worked by Metropolitan Railway.
1915	London Electric (Section now part of Bakerloo Line)	Extended to Queens Park and through service to Willesden over London and North Western Railway tracks began.
1917	„	Services extended to Watford over London and North Western Railway tracks.

MAIN LINE ELECTRIFICATION

1909	London, Brighton and South Coast (now Southern Region)	London Bridge to Victoria (via Denmark Hill).
1911–12	„	Victoria (via Balham) and London Bridge (via Tulse Hill) to Crystal Palace.
1915	London and South Western (now Southern Region)	Waterloo to Wimbledon (via East Putney).
1916	„	Waterloo to Hounslow, Shepperton, Kingston, Hampton Court and Claygate.
1916	North London (now London Midland Region)	Broad Street to Richmond.

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1919–33

	LONDON TRANSPORT	
1920	Central London (now Central Line)	Services extended to Ealing Broadway over Great Western Railway tracks.
1923–24	London Electric (Section now part of Northern Line) . .	Golders Green to Edgware Extension opened and through services commenced over City and South London Railway (rebuilt with enlarged tunnels).
1925	Metropolitan	Harrow to Rickmansworth Line electrified and Watford Extension opened, jointly with the London and North Eastern Railway.
1926	City and South London (now Northern Line) . . .	Through services commenced from Morden to Edgware and Highgate via Charing Cross and Bank.
1926	London Electric (Section now part of Northern Line) . .	Clapham Common to Morden Extension opened Charing Cross to Kennington Line opened . .
1932	Metropolitan District (now District Line)	Services extended to Upminster.
1932	Metropolitan (now Bakerloo Line)	Wembley Park to Stanmore Extension opened.
1932–33	London Electric (Section now part of Piccadilly Line) . .	Finsbury Park to Cockfosters Extension opened and through services to Hounslow and Uxbridge commenced.
	MAIN LINE ELECTRIFICATION	
1922	London, Midland and Scottish (now London Midland Region)	Euston to Watford and Croxley Green (via Queens Park).
1925	Southern (now Southern Region)	Victoria and Holborn Viaduct (via Herne Hill and Shortlands) and Holborn Viaduct (via Nunhead and Shortlands) to Orpington.
1925	,, ...	Nunhead to Crystal Palace.
1925	,, ...	Claygate to Guildford, and Raynes Park to Dorking North and Effingham Junction (via Leatherhead).
1925	,, ...	Victoria to Purley and Sutton (via Selhurst).
1926	,, ...	Charing Cross and Cannon Street to Dartford (via Woolwich, Bexley Heath and Sidcup Lines), Bromley North, Orpington, Hayes and Addiscombe.
1926	,, ...	London Bridge to East Croydon (via Forest Hill).
1927	London, Midland and Scottish (now London Midland Region)	Watford to Rickmansworth.
1928	Southern (now Southern Region)	Purley to Caterham and Tattenham Corner.
1928	,, ...	Sutton to Epsom Downs.
1929	,, ...	Herne Hill to Wimbledon.
1929	,, ...	Crystal Palace to Sydenham and Beckenham Junction.
1929	,, ...	Clapham Junction to Epsom (via Mitcham Junction).
1929	,, ...	Wimbledon and Sutton Railway opened.
1930	,, ...	Hounslow to Windsor.
1930	,, ...	Dartford to Gravesend.
1930	,, ...	Wimbledon to West Croydon.
1932–33	,, ...	Coulsdon North and Purley to Brighton and West Worthing (including Reigate Branch).

1934–49

LONDON TRANSPORT

1939	Bakerloo Line	Baker Street to Finchley Road Extension opened and through service to Stanmore commenced.
1939–41	Northern Line	Extension of services to High Barnet and Mill Hill East over London and North Eastern Railway tracks.
1946–49	Central Line	Extensions of services to Hainault and Epping in the East over L.N.E.R. and, later, Eastern Region tracks and to West Ruislip in the West.

MAIN LINE ELECTRIFICATION

1934–35	Southern (now Southern Region)	Bickley and Chislehurst (via Swanley) to Sevenoaks, and Orpington to Sevenoaks.
1935	„	Woodside to Sanderstead.
1937	„	Surbiton to Staines, Alton and Portsmouth.
1938	„	Three Bridges to Havant (via Ford).
1938	„	Dorking to Horsham.
1938–39	„	Motspur Park to Chessington Line opened.
1939	„	Virginia Water to Reading and Ash Vale.
1939	„	Swanley to Gillingham.
1939	„	Otford to Maidstone East.
1949	Eastern Region	Liverpool Street to Shenfield.

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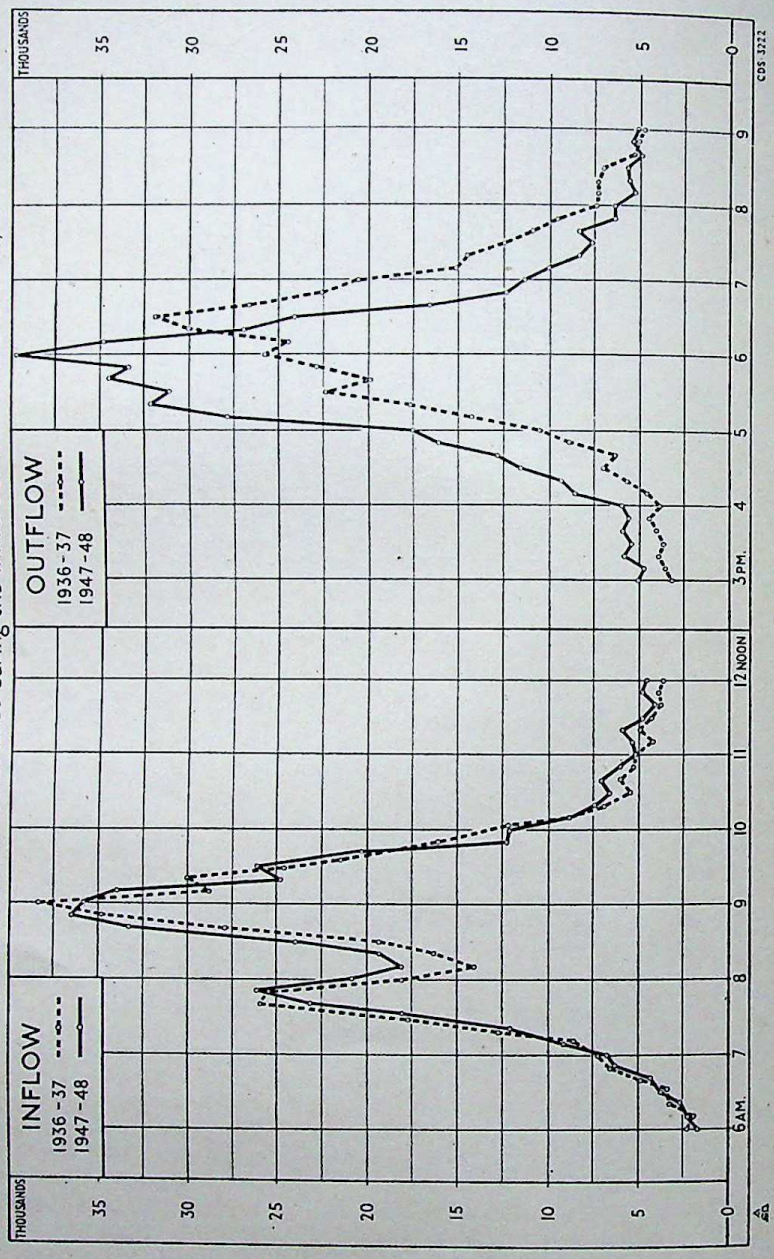
Appendix C



Note.—Figures plotted for ten-minute intervals.

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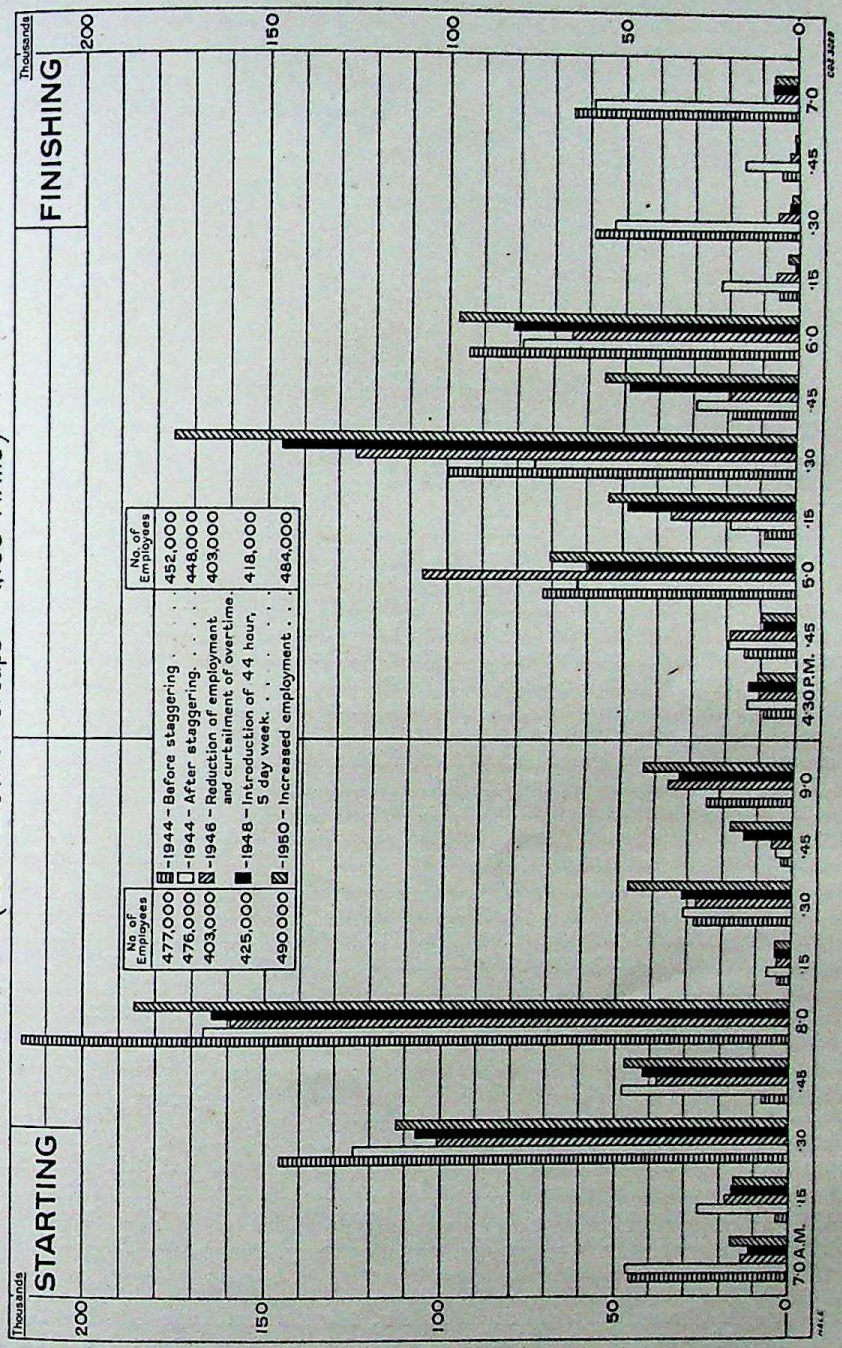
Appendix D



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Discussion on Mr. Menzler's Paper

Dr. K. G. Fenelon, in proposing a vote of thanks: As Mr. Menzler points out, it is nearly fifty years since a Paper on this subject was read to the Society, and I am sure we all agree that he has added greatly to our knowledge and has done a real service in bringing this subject before us to-night.

The fifty years covered in his survey have shown an immense change in the whole scene. Indeed, the situation has been transformed by the advent of the petrol and more recently of the oil-engine bus. Many of the problems, however, are different in degree rather than in kind. London over the past 500 years has been growing in size. There were complaints even in the time of Elizabeth of the inordinate growth of the capital. It has always been assumed to be too big, but nevertheless it has continued to grow. The demand for rides has been increasing ever since public transport facilities have been provided. The interesting point is that this demand has increased at a greater rate than the growth of London. Mr. Menzler has produced in Table 15 some figures which give emphasis to this fact. Over the period with which he deals the number of rides per head of population has increased from 177 annually in 1901 for Greater London to 513 in 1949 for the London Transport system, which covers much the same area. That is a surprising example of a tendency which has been continuous and is indeed shown in all large cities, namely, the tendency for the use of transport to increase at a greater rate than the population.

Some years ago I made some calculations concerning the increase of transport for the country as a whole. I found that the average adult male in 1937 made about 300 journeys in the year, of which 160 were by motor-bus, 107 by tram or trolleybus, and 33 by rail. I found also that the total journeys per head per annum were about twice as many in 1937 as in 1914.

It was to meet the growing demand for transport that almost exactly 100 years ago the top deck—the "outside" as the conductor still calls it—was introduced on the horse buses. It had then one long back-to-back seat, far removed from the comfortable and luxurious seating of Mr. Menzler's top-covered buses. But the "knifeboard" bus did a great deal to increase the seating capacity of London's buses, and two years later, in 1851, there was a great demand for transport as a result of the traffic generated by the Great Exhibition of that year. If a similar proportion of increase in traffic takes place during the Festival of Britain in 1951 Mr. Menzler will have the greatest difficulty in coping with it. In fact, one does not see how it can be possible in the next few years to increase facilities without some radical change in London Transport methods. Something, of course, can be done to regain pre-war efficiency on the tubes and to increase the number of buses, of which until recently there has been a serious shortage. The replacement of old vehicles, the improvement of rolling-stock and greater acceleration will also help.

The cost of providing new underground railways is, of course, desperately heavy. The crux of the London Transport problem is, as Mr. Menzler has emphasized, the peak hour traffic. That is a problem common to all cities, in every country in the world. The French call it the *heures d'affluence*, though I doubt whether that would be the name an English operator would give to it. On the contrary, he finds it the most expensive part of his transport provision. Costs are increased because extra vehicles have to be provided. In cities like Birmingham the buses used for peak hour traffic may only make a few journeys each day and are laid up for the rest of

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the time. The problem in London is not quite so acute. There is a great deal of coming and going at all times of the day, and the buses find remunerative work between the peaks.

London's equivalent of the buses of limited use in the provinces is the tube, which provides the extra facilities for carrying the peak traffic. The expense there is very heavy, and in a way it is, broadly speaking, the equivalent of the cost involved in the extra buses employed in the provinces.

It is significant that just before the war practically every transport conference was concerned with this problem of peak hour traffic and its cost; the fares to be charged for it, and the difficulties of the operators in providing the facilities. Unfortunately, from the traffic operator's point of view, much of the traffic at the peak hour is carried at the lowest price. The workmen's ticket system involves less takings per seat at that time of the day. Moreover, the traffic tends to be unidirectional.

It is interesting also to find the great increase in the number of rides per day, while at the same time it is stated that as many as 17 per cent. of the workers walk to their work. That fact was brought out by the travel survey. Mr. Menzler has performed a valuable service in giving us details of travel facts. If I am not speaking out of school I believe that he was mainly responsible for the inauguration of this most interesting survey. It provides facts, such as, for example, the time taken to travel to work, about which we had no information previously.

Mr. Menzler has rightly pointed out that the root of the matter lies in the conventional time for starting and finishing work. He also deals with the spread of peak hour travel which has taken place to a moderate extent, but leaves the peak hour still a major problem. The staggering of hours is a useful palliative, but has everywhere proved difficult to achieve. During the war it was a little easier. People were prepared to try new ideas, and moreover, hours of work were long, with considerable overtime. To-day, under more normal conditions, nobody cares to work later than anyone else, and the working hours in factories and shops are coming much closer together. In the morning peak, where there is some natural variation, perhaps some staggering will be possible, but the peak for the 5 to 5.30 o'clock return home remains obstinate. That fact is illustrated by the diagram in Appendix D, which shows that the travel peak at 5.30 p.m. has increased as compared with the pre-war level.

I have very great pleasure in proposing this vote of thanks.

Mr. G. J. PONSONBY, in seconding the vote of thanks: Those of us who come from the world of transport know Mr. Menzler as a master of his craft. Not only has he a national reputation, but an international one too. I for one shall regard his Paper as an indispensable source of information and learning for anyone who sets out to study this great problem of London's transport.

I think one of the most interesting facts disclosed in the travel survey for 1949 was that of all workers in London only 58 per cent. are taken to work by the public forms of transport. Thus, having swept into one single whole all the public forms of transport, there is still a large number of workers who prefer other means of transport, such as boots and bicycles. The degree of monopoly is thus severely limited.

There are competitors with London Transport for the journey to work, including walkers (17 per cent.) and cyclists (14 per cent.). Perhaps the most important competitor with London Transport generally is the practice of not travelling at all. We can stay at home and cultivate our gardens. I should like to know the comparative travel habits of (i) those who live in the suburbs and have gardens to cultivate, and (ii) those who live in flats in the middle of London, have no gardens, and at the week-end feel restless and want to get out and about. I have no doubt that Mr. Menzler is watching very carefully the development of television, which may come to be an important indirect competitor with London Transport.

I want to raise one major point of historical interpretation. It is in connection with the evolution of London's Transport over the last fifty years, and in particular the relationship between the old Underground Group and the buses. We are given to understand that in any system of suburban transport, in order to have tubes at all, it is necessary to have a single control over both the tubes and the road passenger services. In the last fifty years it has been argued time and again that it is absolutely necessary to have this *combined* control of the Underground *and* the buses; otherwise, we are told, the tubes would have to close down, or at least stop expanding.

There is another way to interpret this "urge" towards co-operation or combination which we have seen over the last half-century. There was, it would seem, in the first decade of the twentieth century an Underground railway boom in and around London. There was over-optimism by way of investing money in Tubes. Neither the Royal Commission (1904) nor the Local Authorities, who were developing their trams, fully anticipated the potentialities of the internal combustion engine, and many local authorities in London and elsewhere suffered by

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their lack of foresight. Having regard to that Underground railway boom, it was not surprising that Lord Ashfield wished to control the development of omnibuses on the streets of London also. From his point of view such control was a most attractive proposition. And it is well known that in the twenties the financial position of the Underground group was to an important extent safeguarded by the high profits earned by the buses.

But I do not accept the view that we should have "lost" our underground railways had that combination not taken place, or that the tubes were run at a loss in the sense that the owners would have been better off if they had shut them down altogether. The financial situation of the Underground group would, of course, have been very different from what it was had the underground railways not been linked to the buses. But we should not have lost those railways.

It seems to me that there was over-investment in the Underground group of railways before the 1914–18 war, and that the link-up with the buses was more than anything else an effort on the part of the Underground group to defend itself against the consequences of that over-investment and against the unforeseen competition of the motor omnibus.

Mr. S. L. G. BEAUFOY said that it was a particular pleasure to support the vote of thanks. He himself was a planner and a Government planner at that, but he was not a statistician, though he controlled a small statistics section, or, more exactly, was in charge of it! He was indebted to Mr. Menzler, who had done a great deal for London planning, and had been a constant help to the Ministry in its endeavours.

As had been stated, even as far back as the time of Queen Elizabeth attempts were made to stem the growth of London. It seemed that the planners had been swept aside by events all through the ages, so that London got progressively larger. No depression elsewhere in the country could really set London back to any extent. Unlike other cities, a great deal of its employment was concerned with personal service, amusements, transport, and so on, and no short-term planning was going to stem the tide of immigrants. The economic restrictions with which they were faced prevented them from decentralizing London as rapidly as they might hope to do, and on the other side, the urgent need for increasing exports brought more and more people into London. They were constantly faced with the argument that they could not possibly stop a new or an expanding enterprise from going on with its work. His colleague, Mr. Elliott, who was present that evening, had been trying to stem this tide in London, and some impression had been made, but they could not hope that there would be any noticeable improvement on a short-term plan.

The growth of London would only be stopped and perhaps reversed by building up attractiveness and opportunities for employment all over the country in provincial cities, and that was going to be a very long job.

He was glad to learn from the Paper of the great help which Mr. Menzler found in the journey-to-work statistics. He also was very sorry to find that there was no longer provision for this in the census form, and hoped some day to see them again.

Shortage of housing was one of the great factors in this transport problem. There was no margin of accommodation, and people could not easily move. Therefore, they had sometimes to make extraordinarily long journeys to get to their work.

What about the future? He could not make more than a passing reference to the recommendation of the London Planning Administration Committee that the question of the large number of autonomous authorities in Greater London should be referred to a Royal Commission. But it was obvious to anybody who thought about these problems that until some central action was taken to co-ordinate the development activities of all these authorities nothing fundamental would be done in London planning. Housing was the obvious case. Day by day they were faced with the claims of housing authorities for land. These demands ought to be co-ordinated not only with each other, but also with the traffic demand, and the resources which they had to put into traffic to supply such demands. They were coming more and more to see to how large an extent movement lay at the root of planning. Most people left their houses in the morning and went to offices, factories, shops, markets. They were all the time on the move.

He could only say how valuable a service Mr. Menzler had performed by once more drawing their close attention to this vital aspect of planning.

Dr. R. E. O. WILLIAMS said that it had been suggested to him that Fellows of the Society might be interested to hear of some work that he and his colleagues had been doing recently, and which perhaps would serve as a gloss on Mr. Menzler's very interesting Paper.

During and since the war there have been a great number of posters declaring that "Coughs and sneezes spread diseases", and some suggestions that the tube trains during the rush hours might

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be important foci of infection. Accordingly he and others had carried out some preliminary tests to find out how many bacteria there were in the Tube trains during the rush hour. They had set up an air sampler in a spare driving cab at the end of one of the cars in the middle of a train on the Northern line while observers were left in the car to count the people and watch whether the windows were open or shut. Then a specimen of air was sucked out of the car and the number of bacteria present in it was counted. This was done on the journey from Golders Green to Morden and back again, six times, during the rush hour.

It was interesting and surprising to find how clean was the air they sucked out of the car. The average number of bacteria per cubic ft. of air was in general not more than 40, whereas in occupied rooms in elementary schools the average bacterial count was between 60 and 100 per cubic ft. In the tube train the maximum count observed was 170, whereas in schoolrooms the maximum was about 400. The counts in various offices and other places had about the same level as the air of the tubes during the rush hour. Even more surprising was the fact that the bacterial count in the air of the train was raised as much by ten or so people coming into the car as it was by the entry of a large number of people, as when the train came from the West-end at the rush-hour period. The suggestion was that most of the bacteria found in the air came off the clothing of the people who got in and from the upholstery of the seats when they sat down. When a large number of people came in the amount of space for them to move about in was restricted, and the opportunities for dispersing bacteria from their clothing were correspondingly limited.

The other important observation was that the bacterial count in the air decreased very rapidly while the people were still present in the car. This suggested that there was certainly no risk of persistent contamination of the air for any length of time.

Mr. ARTHUR LING said that Mr. Menzler had referred to a planner as having stated that London Transport was really responsible for the great extension of London because it had made such extension so easy. This was obviously not true, but there was a grain of truth in it. The first great exodus from Central London took place between the two wars. Half-a-million people left the County area (as Table 3 showed); they left because the conditions were getting too uncomfortable. Young people getting married were not prepared to put up with the slum conditions. The fact that at that time London Transport extended its network enabled them to find new homes on the outskirts of London, and so the sprawl continued. The London Transport authority was only doing its job. But, if the Government of the day had ensured the provision of new homes in new towns or expanded existing towns elsewhere in the country, this job would have been unnecessary. Too much capital had been and was being invested in London in relation to the provincial cities and other parts of the country, and until the balance was restored and there was a carefully thought out plan for the whole country, London would continue to be attractive to people in a measure beyond other places and they would want to live there. For his own part he could not see the expansion of London being held at bay, unless national policy were revised.

Would the new towns attract a population out of London? Years ago Letchworth and Welwyn Garden City were built, following the lead of Ebenezer Howard, with the idea that they would form an alternative development to an extension of London. But London's growth continued. Ebenezer Howard thought that by having a garden city somewhere beyond a Green Belt, London land values and population would fall and London would become ripe for reconstruction. Who would say that the new towns now being built would do anything more for London in this respect than Letchworth or Welwyn? Would they not simply be additional populations in an even greater London—like drops of water falling over the edge of a basin which with the tap still running was already brimming full. Unless the tap was turned off the overflow would be so great that the new towns would just be merged with the suburbs of London.

If London Transport services and facilities were allowed to increase to a great extent the attractiveness of London would also be increased, industry and people would be encouraged to come to and stay in London, and there was no hope for the well-planned community they all desired. He wished to use this opportunity of putting in a plea for a plan which would have regard to the country as a whole. He did not believe in the opportunist policy of allowing factories to extend in London because of the export problem and the need to get goods produced quickly. Something could be done now to divert this activity to underdeveloped areas in the rest of the country. They would pay heavily for it in the future unless a more far-sighted policy was adopted now which would avoid investment of capital in transport and other services in the wrong place.

Mr. BULLWINKLE wished to mention two points. The first, which had been touched upon by a previous speaker, was the reaction on the transport situation of the "frozen state" which existed in housing to-day. People were not free to move to places more convenient for them from the

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travel point of view in relation to their work. The attention of the public had been recently called to the way in which the housing shortage was aggravated by the operation of the Rent Restrictions Acts. The housing position was uneconomic and highly artificial. It was just possible that temporarily this artificial situation had produced a somewhat artificially high level of transport.

His second point was that he hoped people would not be misled by the figure quoted for pedestrians (14 per cent.), as measuring, so to speak, the peril of competition from this source in relation to road transport. Mr. Menzler had already hinted at a horrifying picture, possibly in five years' time, when the flood-tide of the motorized traffic would be surging through our streets. The pedestrian at the moment was having a very thin time, and it might be that by reason of the limitations of our roads in relation to the traffic which they can bear, some further limitations might have to be imposed on vehicular traffic in the interests of pedestrians and possibly cyclists. One must bear in mind that a considerable proportion of pedestrians are physically handicapped by wounds and other infirmities, subject to age conditions, and so on, limitations which are not always readily apparent but which demand consideration.

Mr. M. G. Dixon asked Mr. Menzler to define the "outer areas" rather more precisely. He was apparently justly proud of the fact that the provision of the car-mile had kept pace with the population. But unfortunately, the peak traffic had become more concentrated, and there probably the car-mile had not kept pace with the demand.

Mr. Dixon also noted that on the suburban services of British Railways there was a tendency for some of the public to travel in "pet" parts of the train. That was noticeable in London Transport also, and if the load could be spread more evenly some relief would be afforded, though this was really a matter for the public themselves. It was particularly noticeable that there was crowding in the part of the train nearest to the terminal exit.

The Bakerloo-Watford service had often been quoted as an unsatisfactory combination of urban and outer suburban working, but he personally felt that the recent Central Line Extensions fell in the same category. He also felt that the Green Line service could be utilized to a greater extent for regular traffic if suitable season tickets were available.

Dr. Heron said that the discussion on Mr. Menzler's Paper showed a departure from the usual practice of the Society, because there had been unstinted praise from every quarter. He would therefore like to redress the balance to some degree by calling attention to some minor matters, in which the standard of presentation fell a little below the rest of the Paper.

In Table 1 the population of the County of London and the Outer Ring was given for various years since 1891, but the years were not regularly spaced out although absolute population increases and decreases were given. There were intervals of ten years, then of five years, seven years, four years, two years, five years, one year and four years. It would have been helpful to have had the average annual increases or decreases of population. The same criticism applied to some of the other Tables.

With regard to the charts at the end of the Paper, in Appendix C a little investigation showed that the numbers were based on 10-minute intervals, but that was not stated, and he thought it should be stated, because in Appendix D 15-minute intervals were involved and this was clearly stated. He did not know what justification there was for the decimal points before 15, 30 and 45 minutes, but perhaps that was a "transport" practice.

The following contribution was received in writing after the meeting:

Dr. R. J. Smeed: I also congratulate Mr. Menzler on his Paper, but there are several comments I wish to make.

In the summary of the Paper Mr. Menzler told us that the probable increase in private vehicle traffic will, in a few years, cause serious problems of congestion in London. This is likely, but one wonders how much congestion is caused by London Transport buses, and whether anything can be done to relieve the situation, either by speeding up bus schedules, by altering the routes or by other methods. A part of the possibly unnecessary contribution buses make to the general congestion is illustrated by the substantial number of nearly empty buses one sometimes sees moving slowly through the centre of London, slowing down other vehicles using the roads. Mr. Menzler does not tell us how the various routes of London buses originated, nor whether any consideration has been given to whether they are the best possible routes in the present circumstances. The fact that Mr. Menzler tells us that 32 per cent. of passengers change once and another 10 per cent. twice gives one reason to believe that some rearrangement of traffic routes might be worth while.

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Mr. Menzler's Table 20, giving the distribution of regular journeys by periods of the day, is most interesting. I have compared it with distribution of private cars using the Embankment, the only complete set of private car data in London that I have. The comparison is given below, and it will be seen that the distributions are not very different. An explanation of at least a part of the differences can easily be put forward.

Percentage Distribution of Passenger Journeys and of Private Car Traffic throughout the Day

Period	*Regular Journeys (Table 20, above)* (%)	*Private Cars, Embankment (East and West)* (%)
7 a.m. to 8 a.m.	14	4
8 a.m. to 9.30 a.m.	16	12
9.30 a.m. to 12 noon	8	16
12 noon to 2 p.m.	8	10
2 p.m. to 4.30 p.m.	13	14
4.30 p.m. to 6.30 p.m.	24	22
6.30 p.m. to 10 p.m.	9	13
10 p.m. to 7 a.m.	8	9

Mr. MENZLER replied in writing as follows:

Mr. Ponsonby questioned whether it was "absolutely necessary" to have combined control of the underground railways and bus services in London. That the financial position of the underground railway undertakings was such as to need a radical remedy is clearly shown by the fact that the parent Underground Company paid no dividend from its formation in 1902 until 1926, eleven years after the establishment of the Common Fund. Without this financial link between underground and road services, tube railway development in London would have come to a standstill. The attraction of the easy return on capital invested in bus operation would have led to the provision of a multiplicity of road services, whilst the uneconomic underground railways, which are the backbone of London's transport system, would never have been developed as needed to meet passenger traffic requirements. The traffic would have been thrown on to the roads, and street congestion would long ago have become intolerable.

There may have been, as suggested by Mr. Ponsonby, a degree of over-investment by the early promoters of the "tubes" before World War I, but this was certainly not true of the extensions—only one of them was entirely in tube—carried out afterwards by the Underground Group. On those, for instance, to Edgware, Morden and Cockfosters, traffic quickly became heavy and amply justified the capital outlay. It may sometimes be more convenient—and more economical—to anticipate future traffic development somewhat by carrying a new line a little further out than immediately warranted by the traffic already offering, rather than cut the line short and be obliged to re-extend it a few years later through a built-up area. The orderly planning of local passenger transport development is surely dependent on the integration of all forms of transport, rail and road, under one authority with a single financial interest.

Mr. Dixon was of the opinion that the extensions of the Central Line have resulted in an unsatisfactory combination of urban and outer suburban working, as on the Bakerloo service to Watford Junction, which the London Plan Working Party recommended should be cut back at Harrow and Wealdstone. On the Central Line, however, the length of the extensions into Essex is counteracted by the fast timings achieved between Liverpool Street and Stratford, where the stations are placed unusually far apart. Running time between Bank and Epping (17½ miles) is 42 minutes, compared with 52–55 minutes between Piccadilly Circus and Watford Junction (nearly 19 miles). It would not be practicable to cut back the Central Line at, say, Loughton, and operate a parallel "outer suburban" service to serve stations north of Loughton, without the construction of additional tracks, which would be quite unjustified by the potential traffic needs. This self-contained branch requires, in this respect, very different treatment from the main line through Watford Junction.

Mr. Dixon thought that the provision of service generally had probably not kept pace with the growing demand for transport in the peak, as distinct from the slack, hours of the day. For London Transport railways it is possible to compare the ratio of passengers carried to seats provided before and after the war. The figures, which apply to the point of maximum loading on each line, are as follows:

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London Transport Railways

Relation of Passengers to Seats during Peak Hours: 1936/37 *and* 1947/48

Inflow			*Outflow*		
Time (a.m.)	*Passengers Carried per 100 Seats Provided*		*Time (p.m.)*	*Passengers Carried per 100 Seats Provided*	
	1936/37	1947/48		1936/37	1947/48
7.00½–7.30	110	93	4.30½–5.00	73	101
7.30½–8.00	153	133	5.00½–5.10	87	144
			5.10½–5.20	112	176
8.00½–8.10	104	107	5.20½–5.30	128	183
8.10½–8.20	109	122			
8.20½–8.30	127	146	5.30½–5.40	110	183
			5.40½–5.50	149	215
8.30½–8.40	165	168	5.50½–6.00	141	224
8.40½–8.50	209	200			
8.50½–9.00	199	185	6.00½–6.10	146	177
			6.10½–6.20	175	148
9.00½–9.10	167	171	6.20½–6.30	181	129
9.10½–9.20	176	145			
9.20½–9.30	143	139	6.30½–7.00	139	87
9.30½–10.00	110	100	7.00½–7.30	109	73
	143	134		125	136

	1936/37	1947/48
Inflow and Outflow combined	134	135

It will be seen that the concentration of peak traffic since before the war has resulted in a rise in the ratio of passengers to seats between the hours of 8 and 8.40 a.m. and 4.30 and 6.10 p.m. Taking the whole of the peak periods (7–10 a.m. and 4.30–7.30 p.m.) together, however, the proportion of passengers provided with seats has risen somewhat in the morning and fallen by a similar amount in the evening, with little change at all if morning and evening are combined.

Mr. Dixon also suggested that the Green Line services could be utilized to a greater extent for regular traffic if suitable season tickets were available. Weekly tickets are in general issue on the coach services, subject to a minimum rate of 13*s.* 6*d.*, but the charges for these tickets are deliberately held at a level rather above the railway season ticket rates for similar journeys. It would be undesirable to attract any considerable amount of regular traffic from the railways, which are suited to carrying heavy peak loads, to the Green Line services, which are designed to cater for a limited type of traffic and could not deal with pronounced peak movements.

It is true, as Dr. Smeed stated, that empty, or almost empty, buses are sometimes to be seen in parts of central London, but they are rarely empty for any considerable distance along their route. It is inevitable that, when buses are approaching the terminals of routes, very often only light loads are carried, especially if it is necessary to project the route beyond the true traffic objective merely to reach a suitable turning place, which is not uncommon in London. At particular times of the day, a service which is well loaded in one direction may be little used in the other—the most extreme instance being during peak hours; the number of vehicles travelling in each direction must, of course, be the same. Apart from such general factors, an occasional bus will be only lightly loaded owing to the chance incidence of traffic in the slack hours. It would not be desirable, in general, to reduce the existing slack-hour frequency of the central London routes, as the whole convenience of the services to the public for short in-town journeys depends on the fact that there is a bus every few minutes.

The scheduled speeds of the road services are based on periodical timing tests, and necessarily reflect an allowance of time for delays in traffic, which are particularly frequent in central London. In consequence, on occasions when the streets are unusually clear, buses run ahead of time, and

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speed is, therefore, reduced so as to keep to the schedule. It must be stressed that, if, as sometimes suggested, buses running early were permitted as a general rule to proceed at normal speed in advance of the timetable, it would be quite impossible to maintain the regular service required by the travelling public. It is also necessary to mention in this connection that standing accommodation for buses is generally limited by the Licensing Authority, and uncontrolled movement of buses on to a stand must inevitably cause serious overloading of the stand and general disorganization.

It is illuminating to measure the contribution made by buses to street congestion in London against the contribution made by them in carrying passengers, and to compare the bus with the private car in this respect. The position is summed up by the following figures:

	Road Space Occupied per Vehicle (sq. ft.)	*Average Passenger Load per Vehicle*	*Road Space Occupied per Passenger Carried* (sq. ft.)
Bus	195	21·2	9·2
Private car	(say) 80	(say) 1·75	(say) 46

When a double-deck bus is fully loaded, carrying 56 seated and 5 standing passengers, the road space occupied per passenger is 3·2 sq. ft. A bus carrying only 5 seated passengers would occupy considerably less road space per passenger than a private car carrying the estimated average load of $1\frac{3}{4}$ passengers.

Dr. Smeed wondered whether the various routes of the London buses are the best possible routes, in view especially of the proportion of regular travellers who have to change once or more. The pattern of passenger movement from one part of London to another is very diverse, and it is, of course, quite impracticable to provide a through facility for every possible journey. The present system of bus routes has been built up by a process of evolution over a number of years, and is devised, on the basis of experience of passenger movements, so as to give the greatest convenience to the maximum number of passengers. Adjustments are made from time to time to meet changing traffic needs. It would not, however, be a satisfactory solution to the problem to cut up the existing routes so as to branch out to a greater variety of destinations than at present. This would merely increase the service interval on each route and thus undermine the basis of high frequency on which London Transport's road service system has been built.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Abdel Rahman Badran.
Hilton Cecil Calpine.
Leslie Newton Chown.
Jack Burnett Duckworth.
Frank Honywill George.
Harold Thomas Graham.
Krishna Swaroopa Gupta.
Rex Anthony Harvey.
John Charles Jenkins.
John Islwyn Jones.
Glaister Constantine Pantry.
Howard Rees.
Donald Graham Robertson.
William Spendley.
William Walford White.
Arthur Henry Ashford Wynn.

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Coal Production Functions for Great Britain

By K. S. Lomax

Introduction

A coal production function is a relationship between output and the inputs of labour and capital employed in production. If the variables are expressed in physical terms output can be represented by the tonnage of saleable coal produced and labour by the manshifts worked at the coal-face. The figures of capital should, ideally, represent the volume of mechanical equipment used in coal-getting but, although we have information about the numbers of coal-cutting machines and pneumatic picks, we do not know their size or capacity, nor the proportion in active use. However, statistics of the amount of coal cut by machinery and obtained (independently) by pneumatic picks are published, and these (together) provide a series which can be included in the absence of a more adequate indicator of variations in the capital equipment used in coal production. There is obvious danger in taking partial output figures as an independent variable, but this is outweighed by the advantages of an index which signifies actual use of equipment and does so efficiently. Another propitious feature of this measure is that it reflects the increased productivity arising not only from improved and more powerful machines, but also from more regular or efficient use of existing machinery due to the installation of such equipment as conveyors and mechanized haulage systems. It needs to be emphasized, of course, that the resulting relationship will not be a production function in the full sense ; it will not, for example, provide valid confirmation of marginal productivity theory. The question arises whether the area of coal-face worked should be regarded as the input land and included as an independent factor of production. The first point here is that the data necessary to permit this do not exist, but even if this were not so, there are still grounds for doubting whether the variable should be included independently. For the effect of spreading existing capital equipment over more seams or of concentrating it is already included in the measure of capital used; and as regards labour, because of technical organization, traditional customs in the industry and Trade Union practices, variations from a constant relationship between the area worked by hand and the labour employed will be almost entirely explainable on the grounds of the geological structure (particularly the thickness) of the seams being worked. Thus the problem of land, in so far as it is not taken account of in the measurement of capital, is largely the problem of allowing for differences in the natural productivity of seams, a matter which is dealt with later. It might be mentioned that after the 1914–18 war the development of "intensive" mining—the concentration of producing operations into smaller areas of the seams being worked—was a failure and was soon abandoned in favour of conventional methods.

A production function can be determined by applying multi-variate analysis to spatial data or to time-series. For coal-getting in Great Britain both methods can be used, the time series relating to the country as a whole and the spatial data to the twenty-five coal districts. It is not possible to carry out analyses of time-series for individual districts, since data of coal got by pneumatic picks in the different coal regions have not been published for a sufficiently long time. The spatial analysis is carried out for the year 1945, the latest for which such information is available, while the time series are limited to the period 1927 to 1943 by the difficulty in estimating the capital equipment in use before 1927 and the change in definition of manshifts worked at the coal-face after 1943. In the analysis of time-series it is necessary to include a residual time-trend to take account of changes in productivity over time, not associated with the inputs measured in the manner indicated. The definition of capital implies that this residual trend is primarily connected with changes in skill, intensity of effort on the part of labour, and the state of the seams being worked, rather than with technical progress.

It is not possible, in the residual trend, to separate the part mainly connected with the quality of labour from that due to variations in natural conditions, since we have no independent statistical information at all on the former and no regular data for the latter. For the spatial data,

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however, it is possible to introduce an additional variable to allow for varying seam conditions. The differences here are mainly attributable to the thickness of the seams,* and we have information concerning this for each coal district in 1944. Unfortunately, as we have not similar information for 1945 and in 1944 the coal got independently by pneumatic picks was not published, it is not possible to carry out an analysis in which all data refer to the same period, but the average thickness of seams is not likely to have varied very greatly from 1944 to 1945.

The most reasonable type of function to fit seems to be an equation linear in time and in the logarithms of the economic variables. Input elasticities of output would then be constant, and the residual trend a constant proportionate change per unit time.

It is essential in the spatial case to impose the constraint of constant returns, since differences in size of the coalfields are not entirely a matter of "scale of production" in the usual sense, but are related to the geographical accident of the number of mines included. The elimination of varying seam thickness reduces the scope for departure from constant returns to scale, but the productivity of labour will still vary from one pit to another, there will still be differences in natural conditions and, without this restriction, the returns given by the analysis would only to a limited extent be the reflection of economies or diseconomies of scale. In the time study it is not necessary to adopt any hypothesis about the linear homogeneity of the production function because, there, changes from year to year are more closely identified with the concept of "scale," and although it is not possible to introduce the average seam thickness as an additional variable (this is only known for 1944 in the period covered), the residual trend will incorporate time-variation in the average productivity of the seams being worked.

The Data

1. *Time Series (Great Britain)*

Percentages of Average 1927–43

Year	*Output (P)* *Saleable coal produced*	*Labour (L)* *Manshifts worked at the coal-face*	*Capital (C)* *Coal cut by machinery and got independently by pneumatic picks*
1927	111·7	122·8	51·6
1928	105·6	113·5	54·3
1929	114·6	122	64·1
1930	108·4	114	68·3
1931	97·5	102	69·8
1932	92·8	95	73
1933	92·1	92·3	80·4
1934	98·1	95·8	95·5
1935	98·8	93·5	105
1936	101·5	94·9	116·8
1937	106·9	101·7	128.3
1938	100·9	95·6	127·6
1939	102·8	98	135·9
1940	99·7	96	136·9
1941	91·7	87·7	130·6
1942	90·5	88·9	131·2
1943	86·4	86·4	130·6

The above figures demonstrate the increased mechanization and the associated reduction in manshifts worked at the coal face which have taken place during the period, a process which is probably nearer its limit in coal-getting than in other activities in the industry. The remarkable

* The partial coefficient of correlation between production and average seam thickness when capital and labour are held constant is significant, being equal to 0·5. The explanation of this positive value is that the thinner the seam the more has labour to be employed on tasks ancillary to actual coal-getting and, consequently, the lower the output.

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rise in the coal cut by machinery (129 per cent.) took place with only a small increase (approximately 9½ per cent.) in the number of coal-cutters. This can partly be explained by improvement in design and increase in power of the machines, but the chief reason is the introduction of conveyors which facilitated the more regular and efficient use of the cutting machines.

2. *Spatial Data* (1945)

District	*Average thickness of seams (1944) (feet)*	*Output (P)*	*Labour (L)*	*Capital (C)*
		Saleable coal produced	*Manshifts worked at the coal-face*	*Coal cut by machinery and got (independently) by pneumatic picks*
		Percentages of average		
1. Northumberland	3·3	136·1	132·6	167·6
2. Durham	3·6	316·1	393	326
3. Cumberland	3·6	14·3	18·5	17·6
4. Lancashire and Cheshire	3·9	149·6	168·9	167·7
5. Yorkshire South	4·2	379·7	305·8	363·2
6. Yorkshire West	3·3	145·6	150·5	146·6
7. Nottinghamshire	4	207·7	141·1	229
8. Derbyshire North	3·8	179·1	126·5	201·8
9. Derbyshire South	5·6	38·5	23·1	43·5
10. Staffordshire North	4·6	79·8	58·2	90·5
11. Cannock Chase	4·7	60·6	54·4	61·7
12. Staffs S. and Worcester	6·7	14·3	11·4	3·4
13. Leicester	4·5	43·7	27·4	49·6
14. Warwick	5·5	62	42·8	55·2
15. Shropshire	3·7	7·8	7·5	8·1
16. Forest of Dean	4	12·5	14·7	8
17. Somerset	2·7	8	12·2	1·1
18. Bristol	4	0·7	1·2	0·1
19. Kent	4·3	17·5	17·5	4·5
20. South Wales and Mon.	4·4	293	416·1	215·4
21. North Wales	5·5	27·2	26	31·2
22. Fife and Clackmannan	4·5	84·8	92·7	91·3
23. Lothians	4·1	47·5	40·5	40
24. Lanark	2·8	125·3	166·5	131·8
25. Ayr	4·2	48·6	51·3	45·2

The Results

1. The *spatial* analysis suggests that, with constant labour and capital, output was proportional to the average thickness of the seams worked, raised to the power 0·57; that is, an increase in seam thickness of 1 per cent., for the same inputs of labour and capital, was associated with a rise in output of about 0·57 per cent.

The dependence of output on the two inputs, when the average seam thickness was constant, appeared to be of the form

$$P \propto L^{0.79} \quad C^{0.21}.$$

Thus,

$$\text{Labour elasticity of output} = \frac{\partial P}{\partial L} \cdot \frac{L}{P} = 0{\cdot}79 \text{ (standard error} = 0{\cdot}04).$$

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This means that in 1945 an increase of labour by 1 per cent., capital and seam-thickness remaining unchanged, tended to increase product by 0·79 per cent.

$$\text{Capital elasticity of output} = \frac{\partial P}{\partial C} \cdot \frac{C}{P} = 0{\cdot}21 \text{ (standard error} = 0{\cdot}04).$$

which indicates that an increase of 1 per cent. in capital, with constant labour and seam thickness, resulted in an increase of output by 0·21 per cent.

Since constancy of returns to scale was assumed, only one of the exponents of labour and capital was determined independently by the least squares method as an adjustable parameter in a regression equation, the other being obtained by subtraction from unity. The standard errors of the two elasticities are, in consequence, the same.

The comparison between values of P calculated from the production function and the observed figures can be seen from the following table:

	Percentage of average	
District	*Observed P*	*Calculated P*
Northumberland	136·1	127·1
Durham	316·1	362·5
Cumberland	14·3	17·5
Lancashire and Cheshire	149·6	169·4
Yorkshire South	379·7	332·2
Yorkshire West	145·6	136·6
Nottinghamshire	207·7	159·2
Derbyshire North	179·1	138·1
Derbyshire South	38·5	32·6
Staffordshire North	79·8	70·5
Cannock Chase	60·6	62·4
Staffs South and Worcester	14·3	12·1
Leicester	43·7	33·9
Warwickshire	62	55·2
Shropshire	7·8	7·4
Forest of Dean	12·5	13·2
Somersetshire	8	6
Bristol	0·7	0·7
Kent	17·5	14
South Wales and Mon.	293	390
North Wales	27·2	33·1
Fife and Clackmannan	84·8	100·7
Lothians	47·5	41·7
Lanarkshire	125·3	131·7
Ayrshire and Dumfries	48·6	52·3

It is apparent that the highly productive coalfields (Nottinghamshire, Derbyshire North and Yorkshire South are the most important examples) with high OMS lie above the production surface, while those at the other end of the scale (South Wales and Monmouthshire, Durham, Lancashire and Cheshire) are, as expected, to be found well below.

2. In the *analysis of time-series* the seam thickness could not be introduced, but here the time variable absorbs causes of variation in P other than that due to the volumes of the inputs L and C. The residual trend appears to be a decline of 1·5 per cent. per annum. This figure, which is really an average for the whole period, indicates the fall in productivity independent of changes in labour and capital which took place. It represents the decline in product which would have occurred with manshifts worked at the coal-face unchanged and the tonnage of coal obtained mechanically constant. As suggested earlier, this trend must be due, mainly, to changes in average

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skill, in intensity of effort, and in the quality of labour generally, together with variation in the natural productivity of the seams being worked. With respect to the latter we do know that between 1924 and 1944 the average thickness of seam declined by about 4 per cent.

With variation in the residual factors eliminated the production function takes the shape

$$P \propto L^{0.79} \quad C^{0.29},$$

Labour elasticity of output = 0·79 (standard error = 0·03).

Capital elasticity of output = 0·29 (standard error = 0·02).

If these estimates were taken as true values the suggestion would be that the returns to the factors in coal mining were slightly increasing in the sense that if labour and capital each increased by 1 per cent., output rose by about 1·08 per cent. However, the results are subject to the limitations of sample estimates and, in fact, the sum of the exponents of L and C is insignificantly different from unity at the 1 per cent. level, and is only on the border-line of significance at the 5 per cent. level. It would certainly not be justifiable, therefore, to assume any significant departure from constancy of returns to scale.

The production function derived from time-series, possessing an additional degree of freedom due to the non-imposition of any constraint, provides a much closer fit than the spatial function. This is seen from the following table. It is also confirmed by a comparison of the coefficients of multiple correlation calculated in the two analyses, 0·996 for the time study and 0·965 in the spatial case.

Percentages of average 1927–43

Year	*Observed* *P*	*Calculated* *P*	*Unemployment percentages*
1927	111·7	111·3	9·6
1928	105·6	104·5	10·7
1929	114·6	114·4	10·3
1930	108·4	108·8	15·8
1931	97·5	98·8	21·1
1932	92·8	93·2	21·9
1933	92·1	92·3	19·8
1934	98·1	98·5	16·6
1935	98·8	97·9	15·3
1936	101·5	100·6	13
1937	106·9	107·6	9·7
1938	100·9	100·8	11·5
1939	102·8	103·1	9·6
1940	99·7	100·1	6·4
1941	91·7	90·5	2·3
1942	90·5	90·3	1
1943	86·4	86·9	0·7

Generally speaking, it is seen, by comparison with the general unemployment percentage, that observed values tend to lie above the production surface in good times, and below it when industry is in a depression which is rather unexpected. The reason cannot be that in bad times the factors are under-employed (capital lying idle, labour working short time), since the inputs are measured in such a way that account is taken of this. In times of low demand and heavy unemployment it would have been thought that production would be concentrated on the better seams, that the seams and mines closed down would be the comparatively inefficient and less productive ones; also that it would be the older, less active labour which would be the first to go, and that the average quality of the labour force would rise. On the other hand, it would be expected that in times of full employment and great shortage of coal even the inefficient seams would be kept in production and that dilution of the labour force would be likely to take place. All this suggests that in times of depression the observed values would lie above the production

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surface, and in good times below it. The explanation of the behaviour observed may lie in the process of fitting. This is a smoothing process, the more erratic and extreme fluctuations in the observed values being reduced by the equation calculated. Thus it is almost certain that if data covering anything like a complete cycle are analysed by means of one of the inflexible types of function which are all that we can handle, the calculated values will lie below the observed ones in peaks and above them in troughs. However, one possible economic reason for the deviation of observation from expectation is that in times of depression there is a tendency for the miner to spin out the work in order to avoid unemployment. The figures of OMS and of total tonnage lost through lack of trade rather bear this out.

Conclusions

The input elasticities of output are reasonably consistent in the two analyses and, perhaps surprisingly, agree quite well with the results obtained by Professor Douglas and his collaborators for manufacturing industry.

There are two reasons why the capital elasticity of output is greater in the time than the space study. One is that in the matter of returns to scale the two analyses are not strictly comparable. The larger coalfields will enjoy the advantages of economies of scale only to a limited extent and, with all natural differences and variations in the productivity of labour eliminated, the spatial data would give more or less constant returns to scale even without this being imposed. The time series, on the other hand, relating to Great Britain as a whole tend to suggest, as anticipated, that there may be slightly increasing true returns to scale in coal-mining, although we cannot estimate the "population" value with very much precision. Secondly, the results of the time analysis are averages over the period, and as capitalization proceeded apace between 1927 and 1943, the value for capital at the beginning of the period was presumably appreciably greater than at the end. It would, then, be reasonable to expect the marginal product of capital in 1945 to be less than the average for 1927 to 1943.

With regard to the future, we have to remember that production at the coal-face is already highly mechanized—75 per cent. of output was mechanically cut and conveyed in 1947—and probably under the conditions ruling in Great Britain further expansion is likely to be small. There is, of course, scope for much more mechanization in other directions,* for example, underground haulage and surface cleaning. The policy of increasing the number of face-workers should be well rewarded too. If the additional face-workers were young and enthusiastic, and they were concentrated in the more productive localities, some contribution might be made in arresting the downward residual trend in productivity. If this trend had not operated during the period, production in 1943 would only have been 5·6 per cent. below 1938 instead of the 14·3 per cent. in fact experienced.

* Calculation of the productivities of labour and capital in these other activities raises formidable difficulties in estimating the capital employed. We have detailed knowledge of capacity and power concerning only the electrical equipment employed on haulage, pumping, winding, cleaning, etc. For some branches of the industry this may be adequate (even so it could be dangerous to carry out a time-series analysis because of the different rates of development of electrical and non-electrical machinery), but it is certainly not true for all. For example, it would not have sufficed in coal-getting, for there, even in 1945, 29 per cent. of machines were driven by compressed air and only 71 per cent. by electricity; in 1929 the percentages were 49 and 51. Apart from this, too, a measure which indicates aggregate capacity or horse-power fails to take account of capital which is lying idle or only intermittently used. For the above reasons it would not be expected that very reliable results would be obtained in the determination of output-input relationships, if aggregate horse-power of electrical equipment were used as a measure of capital. This is found to be the case, for example, in the whole coal-mining industry below ground, where the marginal product of capital works out to be a good deal less than for coal-getting only! In underground haulage, however, if we represent coal hauled by H, capital equipment (estimated H.P.) by C, and labour (numbers employed on haulage) by L, the spatial haulage function appears to be

$$H \propto L^{0\cdot74} \quad C^{0\cdot26}.$$

Comparing this with the spatial relationship for coal-getting, we see that the marginal product of capital in haulage seems to be appreciably higher than in getting, which is in accordance with the generally accepted view that coal haulage in this country is under-capitalized compared with the coal-face. But because of the defects in the index of capital, already stated, it would be prudent to regard the haulage results as very approximate.

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The Sources and Nature of Statistical Information in Special Fields of Statistics

Rail and Road Statistics

By F. A. A. Menzler, C.B.E., B.Sc., F.I.A.

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Introduction

1. The continuous growth of transport, and in the size of the units of transport organization, calls for a close scrutiny of all factual matter that has a bearing on costs and efficiency. Thus, as in so many other fields, economic considerations are the prime mover in promoting the development of transport statistics. But economic interest in transport statistics is by no means confined to managements directly responsible for operating public transport; it is shared by many bodies and individuals. The greater the extent to which the economic life of the nation is directed by "planning," the more important is detailed factual knowledge of such basic activities as transport which form vital links in the chain of a planned economy.

2. It is necessary to emphasize, at the outset, the difference between "external" or published transport statistics, and "internal" or domestic transport statistics. The latter are primarily designed to enable the appropriate levels of transport management to visualize the trend of operating efficiency within a limited sphere of responsibility. These statistics, vital though they are to those immediately concerned, are not normally published, and are therefore beyond the scope of the present review, which is merely intended to be a guide to the rail and road statistics

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available to the public. Even this more limited task is not easy to fulfil. At the risk of stating the obvious, it must be emphasized that the activities of rail and road transport are extremely heterogeneous. To some, the notion of transport calls to mind a crowded tube train during the rush hour; others may have a vision of the Flying Scotsman, or of traffic congestion in Oxford Street. Some will visualize a string of coal wagons in the local goods yard, or a convoy of heavy lorries on their overnight journey on the Great North Road. Others again will reflect that they themselves are playing an active part in transport at large, not merely as passengers or consumers, but also as motorists or cyclists, or even as mere pedestrians.

3. In view of the diversity of the subject matter, it is hardly surprising to find that the statistical information relating to rail and road transport is spread over a great number of publications of unequal scope, authenticity and importance. We have witnessed in our time, however, a very marked process of amalgamation and concentration in the transport industry. The creation of the British Transport Commission was the culmination of this process, in which the grouping of the railway companies in 1921 and the creation of the London Passenger Transport Board in 1933 were other notable milestones. The process is not yet complete, for the infant British Transport Commission is still in the throes of reorganization and consolidation. But even the final consolidation of that great organization will still leave much scope for activity to the statistician who is anxious to obtain a comprehensive picture of all aspects of transport and traffic. He will still have to scrutinize a great variety of returns emanating from many different sources.

4. The evolution of statistical material in this country has rarely been a response to the dictates of *a priori* logical analysis. Statistics have arisen in general from the need for numerical data for purposes of administration and control, and have emerged as a by-product of the processes of administration. Nevertheless, some logical approach is necessary if the significance of the available transport statistics, both past and present, is to be appreciated. Before giving an account of statistical sources, therefore, it is pertinent to ask the question: What kinds of statistical material are likely to be of interest to anyone concerned with the operation, supervision, economics, or sociological aspects of transport?

Nature of Transport Statistics

5. If we endeavour, for a moment, to forget any preconceived notions related to the available statistical material and to rely on common sense alone, we should presumably expect transport statistics to cover three main categories of statistical information, viz. (i) the resources of the transport system in physical assets, i.e. capital assets, and manpower; (ii) the use made of or work done by these resources; and (iii) the financial results of the transport system. From this elementary grouping springs the following general, and deliberately over-simplified, classification of transport statistics:

(i) The resources of the transport system—

(*a*) Fixed assets
(*b*) Mobile assets } Capital assets.
(*c*) Staff.

(ii) The use made of or work done by these resources—

(*a*) Operation.
(*b*) Traffic.
(*c*) Operating efficiency.

(iii) The financial results of the transport system—

(*a*) Expenditure.
(*b*) Revenue.
(*c*) Economic efficiency.

Though most of the terms introduced into this elementary classification are no doubt self-explanatory, it may be helpful to add a few brief comments.

6. The statistics of "fixed assets" would, first of all, include the basic data of the mileage of transport routes. The length of railways and roads is obviously an item of fundamental statistical

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importance. There are, of course, even in such a seemingly straightforward item, a number of statistical distinctions such as mileage of "track," "road" and "route," and some of them will be referred to later. The statistics of "fixed assets" would further comprise all the other fixed installations forming integral parts of the apparatus of transport such as railway stations, repair shops, depots and yards; bus and tram depots and workshops; garages, petrol and service stations for road vehicles; street traffic control signals, and so forth. The term "mobile assets" would cover all the many categories of transport vehicles, i.e. railway rolling stock, public service vehicles, and other road vehicles of all descriptions. The statistical account of "resources" would be incomplete without including the human assets, i.e. the personnel engaged in transport of any kind. Under this heading fall the duly classified statistics, not only of railway personnel and staff directly engaged in the road transport industry but, strictly speaking, also of persons engaged in driving and servicing private road vehicles of all descriptions.

7. If a survey of transport resources is virtually equivalent to a description of the "transport system at rest," the statistics concerning the user of the transport system may be said to describe the "transport system in motion." The dimension of "time" now enters into the statistical picture, and all the basic statistics relating to user will be related to a time unit, be it a day, week, four-weekly period, month or year. In the statistics of user, a fundamental distinction exists between "transport operation" and the "traffic carried," although in practice the distinction is not always made consistently, nor is it always possible to do so.

8. In the narrower sense, "transport operation" covers the movement of vehicles of all descriptions irrespective of the traffic actually carried. The basic statistics of transport operation will therefore serve to measure the gross effort of transport performance, expressed, for example, in terms of train miles, engine miles, vehicle miles, capacity ton-miles or seat miles, scheduled or worked; train, engine or vehicle hours in traffic; seats offered on passenger trains or public service vehicles scheduled; tractive capacity available on freight trains or road haulage vehicles actually worked; and number of wagons handled at marshalling yards. In a wider sense, the operating statistics will cover all the factors incidental to operation, such as the consumption of the various forms of fuel and power; the quantities of materials used for maintenance and renewals; punctuality of scheduled working; traffic offences; and accidents.

9. In contrast to "operating" statistics, he "traffic" statistics will record the traffic actually carried, for example, in terms of passenger journeys and, where these can be assessed, passenger miles; number of wagon loads, loaded wagon miles or net ton-miles; passenger user or tonnage handled at given stations; traffic flow in terms of passengers or net tonnage passing a given point, etc. The term "traffic flow" is often, not quite consistently, also applied to the number of vehicles, and therefore requires an exact definition whenever it is used.

10. It is only when one tries to assess the "operating efficiency" or "load factor" of a transport undertaking that the two different sets of statistics, concerned with "operation" and "traffic" respectively, are brought into relation with each other. In doing so, one passes from the realm of "basic statistics" to that of "derivative statistics," which are not based on counts, but are obtained through dividing one basic figure by another. Many familiar and unfamiliar indices of transport efficiency are in this category. Among them are, for instance, the quotient of passenger miles (if these are available) and passenger journeys ("average length of journey"); the ratio of net ton-miles per ton conveyed ("average length of haul"); the quotient of passenger miles per vehicle mile ("average number of passengers per vehicle" or "average loading"); or the number of passenger miles per seat mile. Other indices are the net ton-miles per loaded wagon mile ("average wagon load throughout"); wagon miles per train mile ("average number of wagons per train "); wagon miles per engine hour (a most valuable index of the utilization of motive power); electricity units consumed per car mile; and pounds of coal consumed per engine mile. For road vehicles, the inverse ratio of miles per gallon of petrol is more usual. Other indices in use for road transport are the ratio of "ton-miles per capacity ton-mile" (load factor), and "proportion of mileage run loaded," which is a cruder measure of vehicle user. These are only some of the indices more commonly used. But as any basic figure can be divided by any other basic figure, there is a wide range of derivative statistics in use. One can even discover printed statistics of the number of fatal road accidents related to the number of gallons of fuel consumed.

11. So far, in trying to outlne a basic classification of transport statistics, no mention has been made of monetary values. No statistical assessment of economic efficiency can be made

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without introducing £ *s. d.* Just as the introduction of the time factor marked the transition from the statistics of transport resources to those of transport utilization, the introduction of the money factor marks the further transition to the third category of transport statistics, for convenience here termed "transport finance."

12. Again, a differentiation must be made between the basic and derivative statistics of transport finance. The former will strictly cover expenditure and revenue in the widest sense, including not only the working results of the public transport undertakings, but also capital charges and such items as the costs of road construction and maintenance, the expenditure and revenue of the Road Fund and, as far as ascertainable, the costs of private road transport. The derivative statistics of transport economics will relate the various expenditure and revenue figures to each other and to the operating and traffic figures, and will therefore serve as crude indices of the economic efficiency of transport. A figure often quoted in this connection is the so-called "operating ratio," which is simply the ratio of working expenses to gross receipts. This figure is of little practical value. It cannot, of course, be indicative of the overall financial position, which would have to take account of capital charges. Nor can it, in spite of its name, serve as a measure of operating efficiency inasmuch as receipts are the reflection of charges regulated by statute rather than of those which would prevail in a free transport market. Other familiar measures are the average takings or operating expenses related to passenger journeys, passenger miles, commodity tons forwarded, ton mile, vehicle mile, train mile, mile of road, and so forth.

13. The broad classification of transport statistics outlined above should be capable of embracing all conceivable statistical matter relating to transport. But, as has been explained at the beginning, our transport and traffic statistics do not, and probably cannot, follow such purely logical conceptions. In practice, statistics must flow from the processes of administration. We shall now have to abandon the strictly logical approach, and turn to what is virtually no more than an inventory of the transport statistics available. For reasons of convenience, this inventory may be split into rail and road statistics respectively, although both kinds have several sources of statistical information in common.

14. This is a convenient point at which to acknowledge the great benefit which the writer has derived, and which other students of transport statistics will derive, from the study of certain previous surveys of the subject, notably those prepared by Lord (then Mr.) Hurcomb in a paper on "Official Railway Statistics in Great Britain", read before the Royal Statistical Society in March, 1925, and by Mr. A. E. Kirkus, then Director of Statistics, Ministry of Transport, in a paper on "Road Transport Statistics", read before the Institute of Transport in October, 1936. Mr. Kirkus is also the author of a book on *Railway Statistics—Their Compilation and Use*, which appeared in 1927. Mention must also be made of two early "classics" on railway statistics. One of them is a most valuable handbook written by the late Mr. C. P. Mossop, at one time head of the Statistics Department of the North Eastern Railway, and entitled *Railway Operating Statistics*. This book, which first appeared in 1911, was revised by Mr. F. H. Graveson, and reappeared in 1923. The other book, likewise of great interest, is the *Manual of Railway Statistics*, by Mr. Geo. L. Boag, at one time General Manager of the Great Southern of Spain Railway. These studies are indispensable to any serious student of British transport statistics. They virtually reduce the present writer's task to one of summing up the story and bringing it up to date.

Railway Statistics

General Survey of British Railway Statistics

15. The history of published railway statistics is as old as that of the railways. The first printed accounts of the Stockton and Darlington Railway in 1827 already contained particulars of the tonnage and receipts of the principal commodities conveyed. The first parliamentary recognition of the need for railway statistics dates back to the Regulation of Railways Act, 1840. Following the recommendations of a Royal Commission on Railways in 1867, the statutory requirements were extended by the Regulation of Railways Act, 1868. They were further expanded by the Regulation of Railways Act, 1871, and by the Railway and Canal Traffic Act, 1888. Some of the railway companies, notably the North Eastern, voluntarily published information in excess of statutory requirements. But, generally speaking, the official railway statistics (other than financial accounts) presented yearly or half-yearly to the Board of Trade were confined, up

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to the year 1912, to a few basic figures concerning the mileage of lines, rolling stock, train mileage, number of passengers and tonnage of goods traffic. The annual returns of the various railway companies were consolidated and published by the Board of Trade in what were shortly known as the " Railway Returns."

16. Modern railway statistics may be said to date back to the Railway Companies (Accounts and Returns) Act, 1911, which came into operation in 1913 and embodied the recommendations of a Committee appointed by the Board of Trade in 1906. This Act specified a detailed list of statistical returns to be furnished by the railway companies. The " Railway Returns " for 1913 were amplified accordingly, but owing to the war the issue of annual returns was subsequently suspended until 1919.

17. After the First World War, it was still felt in responsible quarters that the scope of official railway statistics was inadequate, and extensions were prescribed both by the Ministry of Transport Act, 1919 (by which the Ministry was created), and by the Railways Act, 1921, under which the railways were grouped and the four amalgamated companies constituted. The Eighth Schedule to the last-mentioned Act prescribed a list of 19 categories of statistics which were to be supplied by the companies, at specified intervals, in addition to those furnished under the 1911 Act. All but one of these categories were, in fact, forthwith embodied in the periodical statistical returns furnished by the companies to the Minister. In this expanded form, the " Railway Returns," later confined to Great Britain, were continued up to the beginning of World War II. They represent the most important source of information on pre-war railway statistics. Since 1920, the Ministry of Transport also issued monthly statistics of traffic and operating results, relating partly to calendar months and partly to four-weekly periods. This series, called "Railway Statistics," also continued until 1939. The statistical data appended to the annual accounts submitted to the shareholders by the Directors of the former main line companies are reproduced in these returns.

18. During the war, considerations of national security precluded the publication of much statistical information relating to the operations of the main line railways. Shortage of staff also made it necessary for the railways to suspend the collection of some of the information normally collected and to make certain changes in the bases of other particulars. Statistics compiled by the Railway Executive Committee, which assumed control on behalf of the Government, had to be regarded as confidential. They were, however, subsequently published by the Railway Clearing House under the title, *Tables of Statistical Returns Relating to the Railways of Great Britain*, and also in summary form by the Ministry of War Transport in 1946, in a publication entitled *Summary Table of Statistical Returns of Railways of Great Britain*, 1938 *to* 1944. These abridged "Summary Tables" were also published for the years 1945, 1946 and 1947. Thus some measure of continuity throughout the war period was achieved. The returns were finally discontinued when the nationalized railways were taken over by the British Transport Commission on 1st January, 1948.

19. Before nationalization, considerable railway statistical information, both for London Transport and the suburban services of the main line companies, was published in the series of *Annual Reports of the London Passenger Transport Board*. These cover the period from mid-1933 to the end of 1947. As in the case of the main line railways, publication of these statistics was suspended during the war. The "London" traffic statistics for the main and joint lines were, of course, also incorporated in the aggregate figures for the main lines published in the "Railway Returns." From 1933, with the exception of information about electric working the London Transport statistics were, however, no longer included in the "Railway Returns," though the war-time Summary Tables did include certain statistics of the Board's operations. The Board's Annual Reports are therefore the only consistent source of information about the railway traffic local to the area of the Board's operations, whether carried by the Board or by the main line companies and the joint lines; the main line journeys in the London area, although included in the overall figures of the Railway Returns and Summary Tables, are not segregated from the aggregate figures in those publications. The last of the Board's reports, relating to the year 1947, is referred to later in the more detailed review of sources of information. For a general view of the traffic and transport statistics concerning the London Transport Area, reference may be made to the writer's paper on "London and its Passenger Transport System" (*J.R.S.S.*, **113**, 299).

20. Since nationalization, the monthly statistics of traffic and operating results have been superseded by a new four-weekly publication of the British Transport Commission, called *Trans-*

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port Statistics, and most of the material previously included in the annual "Railway Returns" has been embodied in the first *Annual Report of the British Transport Commission*. These publications are the most important sources of current railway statistics; they will be reviewed in some detail.

21. This brief survey of railway statistics would not be complete without a reference to certain statistical returns on special subjects. They are the *Railway Staff Returns* and the *Railway Accident Returns*. The former were issued from 1921 to 1948, and contained the results of a detailed analysis of the staff position during one week in March or April in each year. The figures were classified by companies, departments, grades, sex, etc., and the average weekly earnings for certain categories of staff are also given. The publication showing the staff return figures was revived retrospectively after the war, in an abridged form, and the 1948 census was embodied in the *Annual Report of the British Transport Commission*, together with the new staff statistics of the B.T.C. which, as explained in paragraph 56 below, are not strictly comparable.

22. The accident returns are based on information supplied by the railway companies in pursuance of the "Regulation of Railways" Acts, dating back virtually to 1841. In their "modern" form, the *Annual Returns of Accidents and Casualties as Reported by the Several Railway Companies in Great Britain* have appeared since 1871. In addition, there were the Inspecting Officers' reports to the Minister on railway accidents. In 1913, and from 1919 onwards, an *Annual Report to the Minister of Transport upon the Accidents that Occurred on the Railways of Great Britain* was issued as a separate publication. From 1929 up to the war, the two publications were reunited, the older "Returns" now being appended to the Report. In this amalgamated form the accident returns were revived after the war, covering retrospectively the year 1944 and, in certain respects, the intermediate war years.

23. Some of the statistical summaries contained in the publications referred to above are abstracted in the *Monthly Digest of Statistics* and the *Annual Abstract of Statistics*, published by the Central Statistical Office. The Annual Abstract also contains railway statistics for Northern Ireland, based on figures supplied by the Northern Ireland Ministry of Commerce. A most valuable secondary source of railway statistical information is a publication, originally private, by the Railway Research Service, entitled *The Main Line Railways of Great Britain*, 1923–1937. This volume was the successor of three earlier studies, published respectively in 1929 by the London and Cambridge Economic Service, and in 1931, and again in 1934 by the Railway Research Service. These surveys contain a wealth of summarized statistics of capital receipts and expenditure; mileage of lines and rolling stock; particulars of ancillary businesses; railway revenue and expenditure; as well as operating statistics proper (including accident and staff statistics). The volumes can be consulted in many libraries.

24. In order to convey an impression of the contents of the more important statistical sources referred to in the above general survey of railway statistics, it may be helpful to review in somewhat greater detail the following publications:

Railway Returns (1938).
Annual Report of the London Passenger Transport Board (for 1947).
Railway Accidents (1947).
Transport Statistics (British Transport Commission, 1949).
The First Annual Report of the British Transport Commission (for 1948).

This review will be followed by a brief reference to foreign and international railway statistics.

Railway Returns

25. Taking the last issue (1938) as an example, the returns are prefaced by a "General Report" addressed to the Minister of Transport and logically divided into "Financial Statements" and "Statistical Returns". Section A1 of the returns includes summary tables of aggregate financial and statistical data for British railways as a whole, whilst in Section A2 separate figures are shown for the four amalgamated main line companies then existing. In Sections B and C, detailed financial and statistical returns are given for each railway company.

26. The statistical returns relate to mileage; maintenance of way and works; rolling stock of all types (with details of seating capacity for coaching vehicles); horses used for shunting;

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miscellaneous property; train, wagon and engine mileage; passenger journeys; freight, parcels and miscellaneous traffic; with a great many derivative statistics. Other tables give details of coal, fuel and electricity consumption, and separate track and vehicle mileage figures, etc., for electrified lines. The trends of certain important figures over a period of ten years are shown in diagrammatic form.

27. It may be helpful to refer to a few of the many pitfalls inherent in the "Railway Returns" owing to the important changes that have taken place, with the passage of time, both in the railway systems as such, and in the bases adopted for the computation of certain items. Take, for instance, the various underground railway companies in the London area which were transferred in 1933 to the London Passenger Transport Board. Before this transfer, the statistical returns for these companies were included in the "Railway Returns" (Section A1). After the formation of the Board they ceased to be included in the main tables. Comparable statistics were, however, included in the *Annual Report of the London Passenger Transport Board.* The tables appended to the "Railway Returns" relating to electric railway operation, however, continued to include the railways of the Board.

28. Another potential source of misunderstanding, and a very important one, is the distinction between "passengers carried" and "passengers originating." The number of "passengers carried" by a railway company is indicative of the number of persons who travelled over that company's system, i.e. made a journey which either originated in, terminated in, or passed over, the railway system concerned. On this conception a journey extending over, say, three companies' systems was counted as three journeys. The sum total, thus arrived at, of "passengers carried" by all the companies gave a rather meaningless figure which, whenever there was an amalgamation of companies, decreased for no other reason than that certain journeys ceased to be counted twice or more often. Prior to 1913, the number of "passengers carried" was still the predominant statistical measure. It was only in connection with the reforms of 1913, already referred to, that the number of "passengers originating" was introduced as a truer index of passenger journeys. In the "Railway Returns," statistics of both "passengers originating" and "passengers carried" continued to be published. In the 1938 Returns under review, the number of "passengers carried" over each company's system was still shown in Section C, but in lieu of the aggregate of these figures, the total figure for "passengers originating" was shown. A similar development has taken place in freight statistics. Here, too, every "ton forwarded" was originally counted afresh whenever the system of another company became involved. This practice has likewise been discontinued.

29. Yet another source of error in comparing railway traffic statistics over a number of years is inherent in the fact that, up to 1901, the numbers of season ticket holders were simply added up, no matter whether they were holders of weekly, monthly or quarterly season tickets. This rudimentary method was discontinued in 1901, when all season tickets were related to an annual basis. But it was not before 1913 that a deliberate attempt was made to translate the number of season tickets current into an estimated number of season ticket journeys. This complication is in addition to that arising from the difference between "passengers carried" and "passengers originating," which also applied to the counting of season ticket journeys.

30. In the field of railway freight statistics, a dangerous pitfall is the treatment of so-called "free-hauled" traffic, i.e. the conveyance of materials, stores and fuel intended for the company's own use. This traffic, which can assume considerable proportions, is mostly conveyed in revenue-earning trains, and must be taken into account in measuring the work performed by these trains. The free-hauled traffic is therefore included in certain tables, but excluded in others, and although this fact is referred to in the table headings, there is a risk of confusion if the tables are not carefully scrutinized.

31. Other fallacies in interpreting railway statistics were pointed out by Sir William Wood in the "Alfred Watson Memorial Lecture" before the Institute of Actuaries delivered in April, 1946. For instance, a drop, from one year to another, of the average load in tons is not necessarily due to underloading of wagons. As the loads consist of three main categories of different specific weights, viz. "merchandize and livestock," "coal and coke" and "minerals," a change in the proportions in these categories will affect the average load, with no change in the economy of loading.

32. Though the "Railway Returns" were the mainstay of railway statistics for many decades,

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they are now a thing of the past. There is, therefore, little point in adding, to the bare outline of contents and possible interpretative pitfalls given above, anything in the nature of actual figures. A few representative figures will, however, be quoted from the current railway statistics reviewed below.

Fourteenth Annual Report of the London Passenger Transport Board

33. In this review of sources of railway statistical information, it is necessary to include the annual reports of the London Passenger Transport Board because, as already mentioned, on the formation of the Board in 1933 certain statistics relating to the railways taken over by the Board were no longer included in the "Railway Returns," and were only to be found in the Board's Annual Reports. These statistics were not again associated with the Main Line statistics until they appeared, after the war, in a separate table included in the *Summary Tables of Statistical Returns of Railways of Great Britain*, referred to in paragraph 18.

34. Except for the war years, the annual reports of the Board included, *inter alia*, statistical tables showing the mileage of lines, rolling stock, train and car mileage, number of stations, lifts and escalators, and the number of passenger journeys and receipts originating both on the Board's system and, for journeys local to the London Passenger Transport area, originating on the system of the main line companies and the joint lines. The post-war traffic figures were, however, confined to "passengers originating."

35. The last of these reports, covering the calendar year 1947, includes a special survey covering the whole period of the Board's existence. Inserted in the text are tables comparing the 1947 figures with pre-war figures for the population served, the number of service car miles run, and the total number of staff employed. It may be mentioned in passing that the number of service car miles run by railway vehicles owned or operated by the Board has risen from 174 millions in 1938/39 to 205 millions in 1947. Over the same period, the number of passenger journeys originating on the Board's railways has risen from 473 millions to 554 millions.

Railway Accidents

36. In the *Report to the Minister of Transport upon the Accidents which Occurred on the Railways of Great Britain*, published annually, numerous tables are inserted in the text and thus become part of the narrative. Both in the report proper and in the appended tables, a general classification into (i) Train Accidents, (ii) Movement Accidents, and (iii) Non-movement Accidents is adhered to. Another subdivision distinguishes between (*a*) Passengers, (*b*) Servants, and (*c*) Other Persons. A number of accident categories attributable to certain particular circumstances, e.g. those occurring at level crossings or those due to failures of coupling apparatus, are subject to a more detailed analysis. Trends of accident figures since 1920 are also shown in diagrammatic form.

37. Taking the Report for 1947 as an example, a total of 447 persons were killed in the course of railway accidents, including 154 passengers, 243 members of the companies' or contractors' staff and 50 "other persons," but excluding trespassers and suicides. During that year, 2,797 persons sustained serious injuries and 27,316 minor injuries. Out of 1,388 "train accidents" reported, 355 were collisions, 346 derailments, 484 cases of "running into obstructions" (which in 173 cases were animals), 132 fires in trains and 71 "miscellaneous accidents." Failure of the human element accounted for 44 per cent. of these accidents. Most of the "movement accidents" are due to misadventure or to lack of caution or misconduct of passengers. Five passengers were killed and 1,275 injured when attempting to enter or alight from trains.

"*Transport Statistics*"

38. As already mentioned, the periodical railway statistics issued by the Ministry of Transport were superseded, from January, 1948, onwards, by the four-weekly *Transport Statistics* published by the British Transport Commission. These returns are naturally of a much wider scope, covering as they do all the principal activities of the B.T.C. and its constituent Executives. The primary arrangement of the statistical tables is according to subject-matter, e.g. takings, staff, assets, operations, and only secondarily according to the different Executives and the forms of transport for which each of them was responsible. Even so, to adhere to the distinction here made, merely for convenience of presentation, between rail and road statistics, the review of the

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latter component of *Transport Statistics* will be dealt with under the section of this review devoted to Road Statistics.

39. In comparing the railway statistics contained in *Transport Statistics* with the earlier returns it may be noted that not all the railways in Great Britain have been taken over by the B.T.C. The potential error arising from this fact is, however, negligible. Out of 19,853 miles of "road open for traffic" (excluding London Transport) in 1947, 19,639 were taken over by the B.T.C.

40. Since its inception, *Transport Statistics* has been progressively amplified. Taking issue No. 13 of 1949 as an example, the contents are logically divided into (i) "Current Statistics," (ii) "Aggregates," and (iii) "Trends." The tables are grouped under the main headings, (*a*) Receipts, (*b*) Staff Employed, (*c*) Rolling Stock, and (*d*) Operating Statistics, and it is only for the latter group that sub-headings have been used for British Railways (D), British Road Services (E), Provincial and Scottish Road Passenger Transport (F), London Transport (G), Inland Waterways (H), and Docks, Harbours and Wharves (J). The distinction between the last two sub-headings is of comparatively recent origin.

41. Among the railway returns comprised in *Transport Statistics* are, first of all, "Traffic Receipts," subdivided for "passengers," "parcels, etc., carried by passenger train," "merchandise," "minerals" (i.e. bricks, iron ore, lime, pig iron, stone, etc.), "coal and coke," and "livestock." These figures are related to four-weekly periods. The passenger takings are also analysed for monthly periods, by fare categories and by classes of travel, showing also the average receipt per journey. Similar figures for London Transport railways are related to four-weekly periods. No corresponding four-weekly or monthly figures are published for operating expenses, so that no figures for net revenue are available for periods less than a year.

42. Staff statistics for the British Railways and London Transport give details of the numbers of male and female persons employed in certain broad groups at the beginning and at the end of the four-weekly period concerned. Details of recruitment, wastage and net transfers during that time are also provided.

43. The rolling stock statistics show the "operating stock" at the beginning and end of the period. The figures cover locomotives, coaching vehicles and freight vehicles of many descriptions and, incidentally, also railway-owned road vehicles and their horses. (It may be noted in passing that there are still some 170 horses engaged in shunting on the British Railways.) Separate figures are given for the electric stock of the British Railways and London Transport respectively.

44. Under the heading "Operating Statistics—British Railways," the recent issues of *Transport Statistics* include fairly extensive statistical material. "Passenger journeys originating" are shown both *in toto* and separately for each of the six railway Regions, analysed by fare categories and classes of travel, and compared with the corresponding figures for the previous year. Similar statistics for "Freight traffic originating" are amplified by estimates of net ton miles and derivative statistics such as net ton miles per ton (i.e. average length of haul), per train engine hour, per engine shunting hour, and per train mile (i.e. average train load).

45. As has been pointed out already, these figures provide important indices for the appraisement of operational efficiency, especially if compared with those for other regions or for previous years. To some extent, however, the differences are due to geographical peculiarities, or abnormal causes, e.g. freak weather conditions. For instance, the utilization of engines in the North-Eastern Region shows an improvement from 573 net ton miles per total engine hour in the four weeks ending 5th September, 1948, to 621 in the four weeks ending 11th September, 1949. This is partly due to an abnormally low ratio in 1948 because of extensive floods in the area, and only in part due to a general upward trend of the relevant efficiency factors. The low figure for the Southern Region (388 in the four weeks to 11th September, 1949) may be due to the comparatively shorter haul and lower density of freight traffic in the South of England, which entails a comparatively high ratio of shunting engine hours to train engine hours. Also, owing to the absence of heavy industries, the "average wagon load throughout" is lowest in this Region.

46. There follow the basic statistics of "train miles," "engine miles," and "engine hours in traffic." In the statistics for "engine miles" and "engine hours in traffic," some terms rather unfamiliar to the uninitiated will be encountered such as "Assisting Required," "Assisting Not Required," or "Departmental." The first-named term covers additional engines attached for the specific purpose of assisting the train engine. "Assisting Not Required" applies to those additional engines which are attached to a train merely for the convenience of saving the "path"

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which would be required if the engine were to run "light." In the latter case, the additional engine is not required to assist and counts as a "light engine." "Departmental" engines are those engaged on "departmental" work, e.g. working locomotive coal or ballast trains, etc.

47. The wagon statistics show the numbers of loaded wagons forwarded, the average wagon loads and wagon miles, again including a number of derivative figures, separately for the six Regions and for three main classes of traffic, viz. "Merchandise and Livestock," "Minerals," and "Coal and Coke." In presenting the "average wagon load," a rather important distinction is made between the "average wagon load at starting point" (i.e. "tonnage forwarded" divided by "number of loaded wagons forwarded") and the "average wagon load throughout" (i.e. "net ton miles" divided by "loaded wagon miles"). The latter figure, which is thus weighted by the distance, is generally the smaller, and amounted, e.g., in the four weeks to January 1st, 1950, to 6·79 net ton miles per loaded wagon mile, compared with the "average wagon load at starting point," which was 8·40 net tons. Unlike its predecessor (*Railway Statistics*), *Transport Statistics* does not show the number of wagons handled at marshalling yards and certain freight stations.

48. The wagon and wagon miles statistics are followed by a table which shows the consumption of locomotive coal, electricity units and gallons of diesel oil for all the regions jointly and separately, and also gives figures per engine mile or car mile.

49. The last table under the heading "Operating Statistics—British Railways" is concerned with the rolling stock repair position. Some may argue that this table would be more at home with the rolling stock statistics (which are partly duplicated), especially as it is the only one of the major tables of operating statistics which does not (and cannot) show a regional grouping because certain types of stock, especially locomotives, are sent to centralized repair shops outside the regional area.

50. Further data relevant to railway statistics are to be found under the heading "Operating Statistics—London Transport" in respect of the railways of the London Transport Executive. The close inter-working of London Transport and main line trains over certain railway sections in the London area is the source of certain statistical pitfalls, affecting the figures for "passenger journeys originating," "car miles" and "electricity consumption." Some of the figures relate to the "services operated," others to the "system managed" by London Transport. Thus, the car miles statistics include the mileage run by London Transport trains over certain sections of the British Railways, whilst the figures for electricity consumption are in respect of electric trains on London Transport tracks only. The figures must therefore be used with care.

51. Part II of *Transport Statistics* gives the cumulative aggregates of the basic statistics (but none of their derivatives) for all the monthly or four-weekly periods of the current year. The derivative statistics are, however, prominently included in Part III, which shows the trends of all the important figures by four-weekly periods from 1947 onwards. Those anxious to study the post-war trend of railway operating efficiency will find these tables of great interest. There is, for instance, a notable rise in the efficiency of engine user (net ton miles per engine hour) for comparable periods in 1947 and 1948.

First Annual Report of the British Transport Commission

52. If *Transport Statistics* has, to all intents and purposes, taken the place of the monthly *Railway Statistics*, the continuity of the annual "Railway Returns" is preserved in the *First Annual Report of the British Transport Commission*. This important document is, of course, by no means concerned with railways alone, but with all the activities of the British Transport Commission, so that we shall also have to refer to it again under the heading "Road Statistics." A considerable part of the volume is devoted to tabulated statistics and their explanatory notes. Further statistical data (e.g. punctuality records) are contained in the text.

53. Apart from the purely financial accounts, statistics relevant to railways are to be found under the headings "Working Results," "Assets," "Staff," "Takings," and "Operations." With this grouping some duplication and overlapping are unavoidable. For instance, the statistics relating to the passenger takings of the British Railways are contained under four different headings, viz. (1) in the table of consolidated working results; (2) in a supporting table where the same figure is split into "ordinary," "workmen," and "season" ticket receipts; (3) under the heading of "takings," where the three categories are amplified into six and compared with the previous

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year; and (4) under the heading of "operations," where the same takings are analysed by class of travel. It may be mentioned, however, that in the two last-named tables, a slightly different basis has been adopted in so far as no provision has been made for the clearance of through traffic between British Railways and London Transport Railways.

54. Under the heading "Working Results," the gross receipts of British Railways and London Transport Railways are specified for certain categories of passenger and freight traffic, whilst the working expenses are analysed in greater detail under the sub-headings "Train and Vehicle Operating Costs," "Maintenance and Depreciation of Rolling Stock," "Other Traffic Costs," "Maintenance and Renewal of Way and Structures," and "General Expenses." It may be mentioned in this connection that no satisfactory way has yet been found in this country of splitting the working expenses of British Railways into expenses for passenger and freight working separately, so that it is not possible to compute separate "Operating Ratios" for passenger and freight working. Incidentally, it is perhaps not generally known that a small amount of freight traffic also moves over some London Transport lines. For some purposes the takings from this traffic are included in those of the British Railways.

55. The "Statistics of Assets" are subdivided into (*a*) Rolling Stock, etc., (*b*) Stations, Depots, Yards, etc., and (*c*) Permanent Way, etc. As far as the British Railways are concerned, particulars of rolling stock owned, acquired and withdrawn are given in great detail, both for locomotives, coaching vehicles, freight vehicles, service vehicles and containers. The statistics of locomotives are classified by wheel arrangement, tractive effort and function. The statistics of freight vehicles are classified by tonnage capacity. Particulars of London Transport railway vehicles form part of a table which covers London Transport road vehicles as well. The total number of seats is also given. The numbers of passenger stations, motive power and coaching vehicle depots, goods yards and marshalling yards of the British Railways are analysed by Regions. The principal figures for "mileage of road" and "mileage of track" are likewise analysed by Regions, but this classification is not applied to such supplementary statistics as, e.g., those for non-standard gauge and for electric tracks.

56. The "Statistics of Staff" include the numbers of male and female persons employed by the British Railways and London Transport in certain specified categories, some of which are inextricably mixed up with non-railway personnel, such as the staff engaged in "railway road haulage" and in certain administrative and miscellaneous duties concerned with non-railway matters. In order to preserve the continuity of the more detailed statistics contained in the traditional "Railway Staff Census," the latter is also included in the staff statistics as a separate and independent return. It must be emphasized in this connection that the "staff statistics" and the "staff census" are not strictly comparable, as they are compiled on different bases. The former is based on the pay-roll figures at the beginning and end of the year. In the latter statement, which, as already mentioned, is based on a special analysis of the staff position during one week in March or April, the "number of persons employed" represents the number receiving salaries or wages for the full week, combined with the equivalent number of full-time workers where employees are paid for less than the complete week. Another difference between the Statistics of Staff and the Staff Census lies in the fact that the latter also includes the few railways not belonging to the British Transport Commission.

57. In the "Statistics of Takings," the passenger and freight receipts of, *inter alia*, the British Railways and the passenger receipts of the London Transport railways are analysed in greater detail and related to other statistical units ("passenger journey" or "ton forwarded"; "passenger mile" or "ton mile," "car mile" or "loaded wagon mile," "train mile" and "mile of road"). The totals of these figures are repeated here for convenience of reference so that these tables convey a fairly comprehensive picture. The figures are contrasted with those of the previous year.

58. It may be useful to dwell for a moment on the statistics of "passenger miles" which are introduced into the "statistics of takings" and the subsequent "statistics of operations." Here is an example of a vital item of statistical information which, although used for a number of important derivations, is itself the result of an estimate. The British Transport Commission's Report does not reveal the actual basis of the estimate, but it is obvious that any assessment of passenger miles must be based on a fares analysis of tickets sold. Passenger miles statistics are costly to compile, and, in the 'twenties, the compilation of these statistics was therefore confined to two months of each year, viz. February and September. The last pre-war figure published in the

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"Railway Returns" was that for the month of September, 1934, when the total figure for "passenger miles worked" was found to be just over 1,750 millions, giving an "average distance per passenger journey" of 17·27 miles, and an "average receipt per passenger mile" of 0·67*d.* for the year 1938. From 1943 onwards, broad estimates of the passenger mileage have been published first in the "Summary Tables of Statistical Returns," 1938 to 1947, and referred to in paragraph 18, and now in the British Transport Commission's Report. The figure for the calendar year 1948 was 21,259 millions, which, divided by the number of passenger journeys (996 millions), gives an average length of journey of 21·3 miles. The average takings per passenger mile, irrespective of type of ticket, were 1·38*d.*

59. Apart from the introduction of estimates of passenger miles, the "Statistics of Operations" contained in the British Transport Commission's Report are practically identical with the "Operating Statistics" of the four-weekly publication (*Transport Statistics*) already referred to so that their presentation need not be discussed again. These "Statistics of Operation" represent the most important source of statistical information on contemporary railway operation and traffic in Britain. A brief digression to quote a few outstanding figures may, therefore, be permissible.

60. In 1948 the number of passenger journeys originating on British Railways was 996 millions (compared with 1,265 millions in 1937); 97 per cent. of all journeys were "third class" (including Workmen), leaving only 3 per cent. for first and second class journeys. A perhaps rather surprising fact is that no more than 7 per cent. of all journeys are made at so-called "ordinary fares," as compared with 30 per cent. journeys on Season Tickets, 23 per cent. on Workmen's Tickets, 25 per cent. on Monthly Return Tickets and 15 per cent. other journeys, including those on Excursion, Weekend and Cheap-day Tickets. The greatest number of journeys (368 millions) originated on the Southern Region, which is, of course, indicative of the heavy suburban traffic in that area.

61. The total freight tonnage forwarded was 276 millions (300 millions in 1937), including 55 millions merchandise, 59 millions minerals, 161 millions coal and coke, and 1 million tons of livestock. 36·4 millions of loaded wagons were forwarded, the average length of haul being 72 miles.

62. In the same year, 650 million passenger journeys originated on the railways of London Transport. In this case, the bulk of the journeys (69 per cent.) was made at ordinary fares, 15 per cent. on Season Tickets and 14 per cent. on Workmen's Tickets. The total compares with 511 millions in 1938/39, making allowance for the transfer to London Transport of certain sections of lines on 1st January, 1948. Whilst this increase of 27 per cent. is matched by an increase of 29 per cent. in the number of loaded car miles run (224 millions as against 174 millions), such a comparison, of course, does not necessarily support any contention that congestion now is no greater than before the war, as the average length of journey has increased, and there has been a further concentration of traffic in the peak periods, in spite of major efforts to stagger the hours of work.

Foreign and International Railway Statistics

63. The reader will hardly expect this survey, which is essentially concerned with British statistics, to include anything like a comprehensive review of foreign statistics as well. The following references to foreign and international railway statistics will therefore be confined to a few publications which are particularly useful in comparing British rail statistics and statistical practices with those abroad.

United States

64. In the United States, it is one of the duties of the "Interstate Commerce Commission" to collect and publish prescribed financial and statistical returns of Class I Railways. On the basis of these official summaries, the "Bureau of Railway Economics" of the "Association of American Railroads" publishes regular statistical returns. One recent publication covers the years 1939/47, giving details of capital investment; operating revenue, expenses, and "ratio"; staff and their earnings; freight and passenger traffic; rolling stock of all descriptions; locomotive, train and car mileage; traffic and operating averages; distribution of operating revenues; railway tax accruals; line-haul operating statistics, and fuel consumption.

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65. Another source of statistical information on U.S. railways is the *Year Book of Railroad Information*, a booklet issued by the "Eastern Railroad Presidents' Conference Committee on Public Relations." The statistical material, whilst based on the same sources (Interstate Commerce Commission), is amplified by textual notes and diagrams.

66. In many respects, the scope of these American statistics exceeds that of the British statistics. An important feature, which the American statistics have in common with most other foreign statistics, is the inclusion of gross ton mileage figures, which serve as a measure of the actual traction effort, including not only the weight of the load, but also that of the locomotive and the tare weight of the vehicles attached to it. These figures, if related to "mile of road," represent an index of "gross traffic density," and can be very useful, e.g., to determine the classification of the permanent way, or the merits of electrification. Another interesting feature is the inclusion of "employee hours paid."

67. At this point the reader's forbearance is asked for a brief digression to compare some actual figures which reveal important differences of American and British railway practice. Perhaps the most outstanding difference is that of the average wagon load (net ton mile per loaded wagon mile), which in 1947 was 6·42 (long) tons in Britain, but as much as 32·6 (short) tons in the United States. At the same time, the number of wagon miles per train mile (i.e. wagons per train) was 34·05 in Britain and 52·9 in America. The average train load (net ton miles per train mile) was 158·93 (long) tons in Britain and no less than 1,146 (short) tons in the United States, which, after allowing for the difference in short and long tons, is about 6½ times as great. These figures express a fundamental difference in the principles of freight haulage, which must, of course, be partly ascribed to geographical reasons.

68. Another interesting feature of American railway practice is the great advance of diesel-electric traction, which is reflected in the number of locomotives in service. Whilst the total number of locomotives on Class I railways in 1948 has remained practically constant compared with 1939 (approximately 42,000), the number of diesel-electric locomotive units included in this total has increased from 510 to 8,089. These figures do not take into account the greater individual mileage of diesel-electric locomotives, which would reveal an even more marked trend of ascendancy.

Germany

69. From the point of view of clear and logical presentation, the pre-war statistics contained in the annual reports of the German Reichsbahn are of some interest. In the tables, which are presented in a uniform style, the items are named in a central column, flanked on either side by two columns of figures relating to the last four years. All the items have running numbers, which are also referred to in all derivative statistics so that the origin of all derivative figures can be traced immediately. Incidentally, for a period after World War I, the Reichsbahn reports were also published in English.

70. A strict distinction has been made between "operating performance" (including, e.g., the classified statistics of train, engine and car axle kilometres with many derivatives) and "traffic performance," i.e. the net traffic in tons, passengers, ton kilometres, passenger kilometres, etc. This distinction is in line with the theoretical differentiation between "operating" and "traffic" statistics discussed at the outset. To get over the difficulty inherent in the dual character of the net ton mileage figures, which are, at one and the same time, indices of the operating and traffic performance, both the gross and net ton kilometres are used to express the operating performance, whilst a third set of figures, the "tariff ton-kilometres," is introduced to express the traffic performance. These figures are based on freight charge kilometres, and are somewhat lower than the figures of net ton kilometres actually worked.

71. Another point of interest in the German railway statistics is the replacement of the "car kilometre" by the "axle kilometre," which, in view of the diversity of vehicles, was regarded as a sounder statistical unit. It is also noteworthy that the railway accident statistics are embodied in the tables in summary form, showing the numbers of derailments, collisions, level crossing accidents and "personal and other accidents," as well as the numbers of passengers and employees killed and injured. Separate figures are given for personal accidents ascribed to own carelessness. The accident figures are also related to length of line and to train and axle kilometres operated.

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An International Comparison of Rail Statistical Practices

72. On a few occasions, the statistical practices of the railway authorities in different countries have been made the subject of special surveys by various interested bodies. A notable survey of this kind was presented in 1925 by Mr. A. E. Kirkus as an official report to a session of the "International Railway Congress Association." The survey was entitled "Development of railway statistics with the special view of economy in operation," and was based on a questionnaire which had been submitted to the railway authorities concerned. It is descriptive rather than critical, and covers practically all countries except U.S.A., Germany, Russia and South America. Unusual statistical items or classifications used by certain railway administrations are specially mentioned. The Canadian railways, for instance, use the "potential ton mile" to compare the actual train load with the estimated potential load; they also have detailed statistics relating to the round-trip time of goods wagons.

Statistics of the "International Union of Railways"

73. For an international comparison of rail-statistical results, the most authentic and comprehensive sources are the "Monthly Bulletins" and "Annual Statistics" of the body known as the "International Union of Railways." The Union was called into being in 1922 through the initiative of the French Railways, in response to a wish expressed by the Transport Committee of the League of Nations. It comprises the main line administrations of most European and some non-European countries, and has its headquarters in Paris. The establishment of regular "International Railway Statistics" was decided in 1925. The pre-war statistics, which were published monthly and annually in French and German, grew from 4 tables in 1925 to an impressive volume of 19 tables in 1938, with detailed explanatory notes. From 1931, certain statistics for railways not belonging to the Union were also included. The statistics contained in the 1938 volume, which is a book of over 200 pages, are broadly divided, in accordance with a "logical" grouping, into "Transport Network," "Technical Results of Operation," "Financial Results" and "Miscellaneous."

74. The "Transport Network" statistics show the length of lines ("first track" and "all tracks," with figures analysed by gradients, curvature and electrification); locomotives and other automotive vehicles of various descriptions; passenger, freight and service vehicles.

75. The tables concerning the "Technical Results of Operations" show train kilometres and gross-ton kilometres operated (the latter figure, as already mentioned, is not available for the British Railways); locomotive kilometres and either car or axle kilometres operated; number of passengers by class of travel and the weight of luggage carried; passenger kilometres *in toto* and related to kilometres of line, car or axle kilometres, train kilometres and number of passengers (i.e. average length of journey); net tonnage forwarded and net ton kilometres worked (related to similar units of operation).

76. The tables relating to the "Financial Results" show the receipts from passenger and goods traffic respectively (likewise related to number of passengers carried or tons forwarded, passenger or ton kilometres and kilometres of line operated); total traffic and non-traffic receipts; operating expenses, divided into "General Administration," "Operation and Traffic," "Permanent Way and Buildings," "Rolling Stock," "Traction" and "Miscellaneous," and subdivided under each heading into expenses for staff and "other expenses." For purposes of comparison the principal working results are summed up in a special table where the different currencies are converted into "Gold-Francs." Further tables analyse the capital assets, financial results, balance sheets and company capital of the different main line railway undertakings.

77. The tables included under the heading "Miscellaneous" concern staff, accidents, fuel and electricity consumption and taxes, etc., paid by the railway administrations. The staff figures are broken down for certain main categories. The accident figures are detailed for collisions, derailments, numbers of passengers, railway employees and other persons killed or injured. These figures are also related to passenger kilometres and train kilometres. The fuel consumption figures specify not only the quantity of the various fuels used, but also their quality in terms of their calorific value (calories per kilogramme).

78. Appended to the tables are a number of explanatory notes which contain valuable information on the bases of statistical computation used for the different tables. These notes are indis-

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pensable for a proper comparative appreciation of the figures, as the bases of computation are still far from uniform. Aware of this drawback, the "International Union of Railways" have continued their efforts towards a greater measure of uniformity in international railway statistics. The annual statistics, suspended during the war, were resumed in 1946, and contact has been established with the "Inland Transport Committee of the Economic Commission for Europe" at Geneva, so as to ensure that any railway statistics published by these post-war organizations are compiled on a basis similar to that of the Union's own statistics, thus avoiding duplication and misunderstandings. At the same time, these statistics are being still further amplified, e.g. in respect of "loaded wagons forwarded" and empty wagon journeys due to the transfer of rolling stock between separate administrations. Tables are also included relating to the speed of trains and their operating regularity. These *International Railway Statistics*, which are now printed in English and French, are by far the most important source of statistical information on international railway matters. But mention must also be made, in this connection, of the *Monthly Bulletins of Statistics*, issued by the Statistical Office of the United Nations, which contain, *inter alia*, statistics of railway traffic in different countries, measured in terms of tons, ton-kilometres and passenger-kilometres. Where available, these figures are given in annual totals from 1937 onwards, and in monthly totals for the last two years or so.

Road Statistics

General Survey of British Road Statistics

79. If the preceding review has served to illustrate the multiplicity and diversity of railway statistics, the following survey of road statistics will reveal a still more chequered picture. So much so that it is, in fact, somewhat difficult to present a catalogue of road statistics in any consistent order, let alone in the logical order discussed at the outset. The obvious reason for this multiplicity is the far-reaching division of responsibility for the various aspects of road transport and traffic. The responsibility for road construction and maintenance is shared by the Ministry of Transport, which is also responsible for the administration of the Road Fund, and hundreds of local authorities. Responsibility for the general supervision and control of road traffic and transport (including road traffic signalling, road traffic census, road traffic offences and road accidents) is shared by the Ministry of Transport, a great number of police authorities (reporting to the Home Office), the licensing authorities for public service vehicles (formerly known as the Traffic Commissioners), and the licensing authorities for goods vehicles. Finally, the responsibility for road transport operation is shared, for the present, by the British Transport Commission, by hundreds of local authorities and private operators providing public transport and, strictly speaking, by several million private road users responsible for the operation of their own vehicles.

80. A few publications, notably those published by such bodies as the British Road Federation or the Society of Motor Manufacturers and Traders, endeavour to convey an all-round picture of road transport and traffic, by collecting statistical material from various sources and, in some cases, contributing original statistics of their own. These publications, as well as the relevant road statistics contained in the British Transport Commission's *Transport Statistics* and Annual Report, are first on the list of those to be reviewed in some detail. Mention may also be made, in this connection, of certain publications by the "P.E.P." Group (Political and Economic Planning), e.g. on the motor industry and cycle industry, which contain statistical data about road transport.

81. Next on the list are the *Tramway and Light Railway Returns*, an important statistical publication of long standing which, although chiefly concerned with trams and trolleybuses, also contains valuable statistical information on related matters. This return, which for many years was called the *Return of Tramways and Light Railways* (*Street and Road*), dates back to 1877 and has since been published annually, first by the Board of Trade and later by the Ministry of Transport, right up to 1938, excepting the war years 1915/18. The scope of the return was enlarged in 1904, and again in 1911 when "trackless trolley vehicles" were included for the first time. In 1921 a committee, headed by Mr. Kirkus, recommended a number of changes in the presentation of the statistics, which were eventually embodied in the Returns from 1924. The

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1938 Returns, which are the last of the pre-war series, will be reviewed below. It is understood that publication is being resumed for 1949.

82. If we turn now to the more specialized statistical sources, there are first those concerned with the road network as such. The classification of roads in Great Britain originated in 1920, and was modified by the Trunk Road Acts of 1936 and 1946. Since 1930, detailed information on the classified mileage of, and expenditure for, roads and bridges has been incorporated in the *Report on the Administration of the Road Fund*, an annual publication of the Ministry of Transport.

83. As to statistics of road vehicles, the most important source of information is the Ministry of Transport publication commenced in 1922 and now entitled *Mechanically-propelled Road Vehicles—Great Britain*. The quarterly version shows the taxation receipts, the numbers of vehicle licences current, and the numbers of new registrations in each category as well as by licensing authorities. The annual version, reviewed below, includes an annual census of vehicles for which licences were current during the quarter ended 30th September, which is the peak season for road vehicles. The first census of this kind was taken in 1926 (see Bibliography).

84. More specialized information on the number of public service vehicles is contained, not only in the *Tramways and Light Railways Returns* already referred to, but also in the *Annual Reports of the Licensing Authorities for Public Service Vehicles*, which were known, before the Transport Act, 1947, as the *Annual Reports of the Traffic Commissioners*. The institution of the "Traffic Commissioners" dates back to the Road Traffic Act, 1930, which also contained statutory powers for the Minister of Transport to require financial and statistical returns from all persons or undertakings operating public service vehicles. Summaries of these returns are appended to the Annual Reports which are published by the Ministry of Transport. Valuable statistical information on municipally operated public service vehicles is also contained in pre-war statistics specially prepared for the periodical *Transport World*. In addition, there are, of course, a multitude of individual Annual Reports of the separate municipal or other transport undertakings, containing, in the aggregate, a wealth of statistical information which it is hardly possible for any single student of transport statistics to collect, let alone digest. It may be mentioned that certain popular publications on buses, trams and trolleybuses, e.g. the "Ian Allan" publications on London Transport road vehicles, contain a great deal of statistical information of a kind which students of road statistics may appreciate.

85. Statistical information relating to goods vehicles under carriers' licences, in accordance with the Road and Rail Traffic Act, 1933, is contained in the *Annual Reports of the Licensing Authorities*. These were published for the years 1934/35 to 1937/38, but publication has now been resumed with the issue for the year 1947/48. In addition, a special publication of statistical tables was made for April 30th, 1936, giving details of the number of licences of the different categories ("A," "B" and "C," "Currency" and "Short Term" Licences) issued in each "Traffic Area." The figures for "B" Licences were also broken down for "nature of business," "classes of goods" and "permitted zone of operation."

86. Attempts to obtain quantitative information on the actual traffic on the roads of Great Britain date back to the time before World War I. In 1910/11 the Road Board, in connection with applications for grants, obtained statistics of traffic on a certain number of roads which were to be improved. Thus, in 1911, a fairly complete census was taken on certain Sussex and Kent main roads. Traffic counts in the Metropolitan and City of London Police Area go back to 1904, although during the early years they were on a more restricted scale than from 1925 onwards, when counts were taken biennially (excepting 1929) until 1937. The report dealing with 1937 will be referred to later.

87. The first traffic census on a country-wide basis was carried out on Class I Roads in August, 1922. The chief results are contained in a special Ministry of Transport publication, *Road Traffic Census*, 1922. Certain resul s, e.g. the average daily weight of motor traffic on the various sections of the London–Edinburgh Road (A1) and others, are also presented in diagrammatic form. Further censuses of this kind were taken in August, 1925, 1928, 1931, 1935, and 1938. In intermediate years (1923, 1926, 1929 and 1936) similar censuses were carried out on Class II Roads. The results of each census have been published by the Ministry of Transport in special reports. In 1928/29 an additional special census was taken at 24 selected points on Class I Roads over a complete period of 12 months. The results of this census were included in the report for 1928.

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88. Statistics concerning traffic offences originate from police reports and are therefore the responsibility of the Home Office. Regular statistics are available for offences relating to motor vehicles, details of which are given in a return submitted annually to the House of Commons by the Home Secretary. Offences are analysed by police areas for a number of specified categories, under the sub-headings "Driver's licence offences," "Excess of speed limit," "Neglect of traffic directions" and "Use of vehicle. This series of publications was also suspended during the war, but has since been resumed.

89. The responsibility for analysing road traffic accidents is shared by the Home Office and the Ministry of Transport. Road accident statistics can be traced back to 1909. The basic source of information on road accident figures before the war was a Home Office publication, presented annually to the House of Commons and, since 1934, entitled *Road Accidents involving Personal Injury*. Since 1937, responsibility for issuing this publication rests with the Ministry of Transport. With the object of analysing the circumstances and causes of road accidents, the figures for the years 1933, 1935 and 1937 were used as bases for three special reports published by the Ministry of Transport. Whilst the first two of these reports were concerned with fatal accidents only, the latest of them has been extended to include non-fatal accidents as well. Present statistics of road accidents are issued monthly by the Ministry of Transport in the form of typewritten Press Notices which specify the number of persons killed, seriously injured, or slightly injured, on the roads of Great Britain, distinguishing between different categories of persons; hours of darkness and other hours; and roads subject or not subject to a speed limit.

90. Among other important sources of road accident statistics may be mentioned the war-time *Road Accident Statistics* published as "Bulletins" of the Royal Society for the Prevention of Accidents. Bulletin No. 20 in the series covers the entire war period. It is compiled from the official monthly figures published by the Ministry of War Transport. Mention may also be made of an internal publication of the Statistical Branch of the Metropolitan Police which, supported by maps and diagrams, analyses the road accidents in the Metropolitan Police Area in 1947.

91. Before turning to the scrutiny of specific road statistics, it may be useful to refer to the more outstanding gaps in our road transport statistics. There is, for instance, an almost complete absence of statistical information relating to the volume, nature or cost of the work done by road goods transport. This gap will be narrowed in the course of time, as an increasing volume of road haulage will be concentrated in the hands of the Road Haulage Executive of the British Transport Commission, and therefore be covered by the British Transport Commission's statistics. Nevertheless, a substantial volume of goods transport on the roads is bound to remain in private hands, and therefore outside the range of the official statistics. To assess this traffic, nothing more tangible is available than the number of goods carrier licences current, and, possibly, a rough estimate based on the traffic census figures of the volume of goods traffic carried on the roads. For the assessment of operating costs of commercial motor vehicles, certain tables published by the periodical *The Commercial Motor* will be found valuable.

Review of Selected Road Statistics

92. It is now proposed to scrutinize the following publications somewhat more closely:

Basic Road Statistics (1949).
The Motor Industry of Great Britain (1947).
Transport Statistics (British Transport Commission, 1949).
First Annual Report (British Transport Commission, 1948).
Tramway and Light Railway Returns (1938).
Report on the Administration of the Road Fund (1947/48).
Mechanically-propelled Road Vehicles (1948).
Road Traffic Census (Class I Roads, 1938).
Census of Traffic—Metropolitan and City of London Police (1937).
Road Accidents Involving Personal Injury (1938).

Again, as in the case of the railway statistics, the survey will be concluded by a reference to foreign and international statistics.

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Basic Road Statistics (1949)

93. This booklet is published annually by the British Road Federation, to which more than a hundred national organizations with road user interests are affiliated. The booklet deserves pride of place, not as an original source of statistics, but as a deliberate attempt to integrate all the vital statistical information on road traffic and transport in a single, if concise, book of reference.

94. The 18 sections of the 1949 edition deal, in turn, with the number of workers employed by road transport; the monetary value of motor vehicle exports and imports since 1932; motor taxation revenue compared with road expenditure, 1922/49; road accident figures, giving the annual numbers of pedestrians, pedal cyclists and "other persons" killed and injured since 1928 and comparing these figures with the motor fuel consumption; number of motor vehicles in use in any year since 1904, with separate figures for private cars, motor cycles, omnibuses and coaches, taxis, goods vehicles and "other vehicles"; numbers of tramcars, diesel-engined vehicles, private-hire cars, horses; mileage and maintenance cost of classified roads; numbers of passenger journeys, total passenger revenue and average fare of the various branches of the passenger transport industry; numbers of licensed carrier vehicles and licence holders in the goods transport industry; numbers, carrying capacity and net receipts of the goods and passenger vehicles of the various Executives of the British Transport Commission; motor taxation and revenue; analysis of road expenditure in general and Road Fund expenditure in particular; and relationship between the Road Fund and the Exchequer since 1910.

95. This rich collection of heterogeneous road statistics from manifold sources, all of which are quoted, makes the *Basic Road Statistics* a useful starting-point for statistical research on roads. A certain degree of caution must, however, be exercised in drawing conclusions from a comparison of the highway expenditure figures pre-war and post-war, from the taxation figures for certain years, and from the relation of road accidents to fuel consumption.

The Motor Industry of Great Britain (1947)

96. This is another most useful reference book of a general character, published annually by the Statistical Department of the Society of Motor Manufacturers and Traders. The first post-war edition appeared in 1947, after an interval of eight years. Whilst much of the information is naturally more concerned with the motor car industry than with road transport and traffic, there is also a great deal of statistical matter directly relevant to road traffic, mostly derived from official sources. In particular, the numbers of vehicles in use are quoted in great detail, by categories and licensing authorities. Here, the official statistics are amplified by the addition of figures for the numbers of vehicles in use in other countries, using the most authentic sources available. The figures are also related to the relevant population figures. The chapters dealing with motor car production, overseas trade and legislation are perhaps more marginal to this survey. Among the "miscellaneous" tables included in the volume are statistics of road mileage, employment in the motor industry, and carriers' licences, as well as a comparison of retail fuel prices throughout the world.

Transport Statistics (British Transport Commission, 1949)

97. This four-weekly publication of the British Transport Commission, already referred to under the heading of Rail Statistics, includes official statistics of the road passenger services operated by the London Transport Executive and the Road Passenger Transport Executive (in respect of the "Tilling" and "Scottish" groups already taken over by the British Transport Commission), as well as on the road freight services operated by the Road Haulage Executive and the Railways Executive (collection and delivery services). As far as the figures are available, and can be segregated from other activities, these road transport statistics cover traffic receipts, staff, vehicles and horses, tonnage forwarded, fuel and electricity consumed, vehicle mileage, passenger journeys and vehicle repairs. It will be appreciated that, as the scope of the British Transport Commission activities is gradually expanding (and this applies particularly to the road services), the scope of the figures published in *Transport Statistics* is likewise expanding. During the present initial stage of nationalized road services, the relevant British Transport Commission statistics, especially those relating to goods haulage, are naturally still far from comprehensive.

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First Annual Report of the British Transport Commission (1948)

98. As in the case of the rail statistics, the figures relating to the first year of road transport under the British Transport Commission are consolidated in the First Annual Report. Again, the figures are wherever possible shown separately for (1) the road haulage operations of the "British Railways" and (2) those of the "British Road Services," as well as (3) the road passenger services of the "Provincial" and "Scottish" groups already taken over by the British Transport Commission, and (4) those of London Transport.

99. The statistics for these four groups include detailed figures of working results, i.e. gross receipts and working expenses under various headings, and the derived figures for net receipts and operating ratios, as well as figures relating to the numbers, capacity, maintenance and depreciation of vehicles; staff; passenger journeys and freight tonnage forwarded, vehicle mileage, fuel consumption, etc. It will be appreciated that, as the British Transport Commission are still in the process of consolidation, it is not yet possible to convey a comprehensive statistical picture of British Road Transport. But the First Annual Report must be regarded as an important and valuable starting-point.

100. A few figures may be quoted to indicate the scope of the various road traffic activities during the first year of the British Transport Commission. The road cartage services of the British Railways, which are mainly concerned with the collection and delivery of rail freight and parcels, handled 28 million tons of freight and 132 million parcels. As is well known, much of this traffic is still handled by horse-drawn vehicles, of which there were 24,821 at the end of the year, compared with 5,873 "Rigid Motors and Tractors" and 6,456 "Mechanical Horses and Articulated Motors." There were 15,731 "trailers of all types" to be pulled by the 6,456 "mechanical horses and articulated motors" as well as by the tractors included with the "rigid" motors, so that the ratio of trailers and tractive motor vehicles must be rather less than 2·4. It may, however, be at first sight puzzling to find that there were only 7,404 horses to draw the 24,821 horse-drawn vehicles, corresponding to a ratio of 3·3 vehicles per horse; this may be partly attributable to the method of "stand loading" and shuttle working.

101. At the same time, "British Road Services" had at their disposal 8,208 Motor Haulage Vehicles (including tractor/trailer "articulated units") and 1,867 horse-drawn vehicles. The road haulage staff totalled over 23,000 at the end of the year. The road passenger staff of the "provincial" (Tilling) and Scottish road transport undertakings, already taken over by the British Transport Commission, totalled over 53,000 at the end of 1948. They controlled 12,114 buses and coaches and 43 trolleybuses.

102. The number of passenger journeys originating on London Transport buses and coaches in 1948 was 2,745 millions, an increase of nearly 8 per cent. over 1947. The corresponding figure for trolleybuses and trams was 1,210 millions, representing an increase of nearly 6 per cent. over 1947. The estimated totals of passenger miles were 6,298 millions for buses and coaches, and 2,754 millions for trolleybuses and trams.

Tramways and Light Railways (Street and Road) and Trolley Vehicle Undertakings

103. These time-honoured annual statistical returns are comparable to the "Railway Returns" in the scope of information furnished. Although their field is contracting, as more and more trams are being replaced by buses, their very existence tends to emphasize the regrettable absence of statistics of similar scope for diesel or petrol buses. Taking the last published returns (1937/38) as an example, the only table covering road passenger transport vehicles of all kinds is to be found in the appendix. Here, summary figures are also included for London Transport road services, which are otherwise wholly excluded from the statements because of the difficulty in segregating the figures from London Transport's other activities. Another source of possible misunderstanding lies in the fact that the returns do not cover a strictly defined annual period. Whilst the financial year of company-owned undertakings usually coincides with the calendar year, this is not the case with undertakings owned or operated by Local Authorities, where 31st March or, in Scotland, various dates in May, are the closing dates of the financial year. It is understood, however, that it is intended to publish quarterly returns which would make it possible to obtain comparable statistics relating to calendar years.

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104. With these reservations, the Tramway Returns give a very complete picture of tram and trolleybus traffic and operation. The financial statements include summaries of the capital and revenue accounts of each undertaking, whilst the statistical tables give particulars of length of lines, numbers of vehicles and their total and average seating capacity, passengers carried, vehicle miles run, vehicle hours worked, etc. Figures are also given of line voltage, electricity consumption *in toto* and per car mile (a figure that shows surprising fluctuations). Average figures for fares, revenue and expenditure per passenger journey and per car mile follow. The "operating ratios" are also shown.

Report on the Administration of the Road Fund (1947/48)

105. This annual report, which has been resumed in an abridged form since the war, contains official statistics concerning the mileage of the various categories of public roads, and the expenditure on them analysed by source of income and by highway authorities. Another table shows the average cost per road mile of "maintenance, repair and minor improvement." Among incidental statistics included in the report are the numbers of successful and unsuccessful driving tests for motor vehicles.

Mechanically-propelled Road Vehicles (1948)

106. As already mentioned, the annual version of this important return includes the results of a census of vehicles for which licences were current at any time during the quarter ended 30th September. These figures afford a very complete picture of the vehicle assets of road transport in general, giving detailed particulars of the numbers of vehicles of different categories by Counties (figures for each Licensing Authority are available in a special typewritten supplement obtainable on request from the Ministry of Transport).

107. A second table gives the total figures for England, Wales, Scotland, and Great Britain for a very detailed list of vehicle categories classified under weight, cylinder capacity, licence duty, seating capacity or certain technical features. Among the major categories are, apart from ordinary passenger cars, motor bicycles and tricycles, pedestrian-controlled vehicles, hackney vehicles (subdivided into "tramcars" and "others"), tractors of all categories, goods vehicles (including "showmen's special vehicles"), watering and cleansing vehicles owned by Local Authorities. Also recorded are so-called "exempt" vehicles, in respect of which no licence duty is payable. They include fire appliances, ambulances, road construction vehicles, invalid vehicles, etc.

108. Some of the figures may be somewhat unexpected, and many will be surprised to find that there were, in 1948, almost as many "Showmen's Vehicles" (4,364) as tramcars (5,560). An interesting feature of recent vehicle statistics is the rapid increase in the number of pedestrian-controlled vehicles (5,367 in 1948 as compared with 3,919 in 1947), which reflects the increasing use of mechanically-propelled delivery vehicles.

Road Traffic Census (Class I Roads, 1938)

109. The latest published report on a country-wide census of vehicular road traffic is based on a general census on Trunk Roads and other Class I Roads, taken in August, 1938, at 5,753 census points. The results contain valuable information not only on the total intensity, composition and local distribution of road traffic but also on traffic trends, and traffic fluctuations throughout the hours of the day, and the days of the week. By using an assumed average weight for each category of vehicles, figures were obtained not only for the numerical intensity of traffic, but also for the total weight, which is of obvious importance, e.g., in selecting appropriate types of road surfaces.

110. The published tables include the classified road mileage, separately for Counties and County Boroughs, and for urban and rural areas; a selection of typical census results from industrial, agricultural and residential-suburban areas, giving the daily average number and weight of vehicles (pedal cycles and tramcars are counted separately); comparative traffic figures for Saturday, Sunday and Monday to Friday at a number of representative points; traffic figures hour by hour at six selected points, etc. Some of the figures are also presented graphically. Diagrams of traffic density are also included for Class I Roads in South-East England outside

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the Metropolitan Police District, and in the vicinity of Glasgow and Edinburgh. It may be mentioned in passing that the greatest volume of vehicular traffic recorded at any point in 1938 was on the Great West Road (A4) at Brentford, where the average number of vehicles per day (6 a.m.–10 p.m.) was 23,520.

Census of Traffic—Metropolitan and City of London Police (1937)

111. The periodical reports on traffic census in the Metropolitan Police Area are an important adjunct to the Class I Road census reports. The latest Metropolitan Police Census Report gives the results of a 12-hours' count at 119 points on a weekday in July, 1937, according to numbers of private cars, light and heavy commercial vehicles, locomotives and tractors, buses, coaches, tramcars, trolleybuses, motor cycles, pedal cycles, light and heavy horse-drawn vehicles and barrows. Aggregating the figures for all these heterogeneous vehicles, by far the greatest number at any one point was counted at Hyde Park Corner, where over 80,000 vehicles were recorded between 8 a.m. and 8 p.m. Trafalgar Square, Marble Arch, Piccadilly Circus and Blackfriars Bridge Approach follow at some distance and in that order.

112. Other tables show the aggregate numbers of vehicles recorded in each hour (the maximum hour being 5–6 p.m.); the percentage of each class of vehicle in the total (38·4 per cent. being private cars); and the increase or decrease of traffic since 1935 and 1927 at comparable points. A separate table details the cross-river traffic all the way from Woolwich Free Ferry to Hampton Court Bridge. Taking the cross-river traffic from Woolwich Ferry to Kew Bridge only, the total number of vehicles crossing the river in 12 hours was 294,760, compared with 274,774 in 1935, Westminster Bridge heading the list with more than 31,000 vehicles. Of special interest is a table contrasting the 1937 results with earlier traffic census results at comparable points, dating back, in many instances, to 1904. At Hyde Park Corner, for instance, traffic in 1904 was less than 30,000 vehicles of all descriptions, compared with over 80,000 in 1937.

Road Accidents Involving Personal Injury (Great Britain, 1938)

113. As already explained, this Ministry of Transport publication is the third of a series of special analyses of road accidents, based on police reports throughout the country. It is the first of the series to include non-fatal accidents. Certain other changes were made as a result of a general discussion on road accident statistics at a Conference of British Commonwealth Statisticians at Ottawa in 1935, and at a League of Nations Committee for the Unification of Statistics relating to Road Traffic Accidents.

114. Total numbers of fatal and non-fatal road accidents in Great Britain are given for all years from 1909 to 1938, the total having risen from 27,161 to 196,368 during that time (the former figure, however, excludes pedal cyclists). The peak year was 1934 with 204,710 accidents. For the years 1928–1937, the accident figures are specified for certain categories of road users (pedestrians, cyclists, persons on mechanically-propelled or horse-drawn vehicles, and "other persons"). Other tables show the monthly fluctuations of accident figures; the classification of accidents according to the type of vehicle primarily concerned; the number of accidents and number of persons killed or injured in each Police District, etc.

Foreign and International Road Statistics

115. Owing to the heterogeneous nature of road traffic, it is hardly surprising to find that international comparative statistics on road traffic are more scanty than rail statistics. Efforts have, however, been made from time to time to collect international data. Mention has already been made of certain international statistics contained in *The Motor Industry of Great Britain*. Also, *Basic Road Statistics*, quoting American sources, contain a table showing, for a number of countries, the number of motor vehicles, the road mileage, and the ratio of these figures, which is somewhat misleadingly, termed "traffic density." In 1929, the Paris headquarters of the International Chamber of Commerce published a brochure entitled *World Highway Transport—A Statistical Survey*, giving estimates of the numbers of vehicles in use, the length of roads, the revenue from motor taxation, and expenditure on road construction and maintenance.

116. United States statistics of road transport may be found in such publications as *Public Roads*, or in the quarterly reports on *Domestic Transportation* issued by the Department of Com-

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merce. Also, the Interstate Commerce Commission regularly issue statistics relating to traffic by "Class I Road" goods carriers.

117. In the field of road traffic statistics there is still a marked lack of uniformity in the scope and methods of road traffic censuses, so that international comparisons of road traffic intensities are beset with difficulty. Efforts have been made from time to time to bring about a greater degree of uniformity by laying down certain standard rules. Thus, in 1926, the 5th International Road Congress at Milan decided to set up a special committee for this purpose. The draft rules, published in 1927, are concerned with the classification of vehicles, the selection of census points, the duration of counts, the adoption of uniform average weights, etc. These rules, however, were too general in character to exercise much influence on the standardization of traffic census methods, and little progress was made in this direction before the war.

118. A notable effort to compare road traffic census methods and results in various European countries was made, before the war, by the Danish Road Research Institute in connection with a country-wide traffic census on Danish highways in 1934. On the basis of a circular addressed to the road authorities of 19 European countries, a survey of census practices as well as census results in the countries concerned was published and tabulated as a special appendix (in German) to the 200 pages report on the Danish census.

119. It may be mentioned in passing that the Danish census, to which the survey has been appended, is distinguished by the thoroughness of its organization and the scientific treatment of the results. At 65 "special census points" observations were made throughout the 24 hours during one week in each of the months February, May, August and November. The results of these special observations were used to analyse traffic fluctuations during hours of the day, days of the week, and seasons of the year; to gain information on the ratio of maximum to average traffic, and on the percentage of traffic occurring during the hours of darkness; and finally to determine the correction coefficients to be applied to the 1,962 ordinary census points where observations were confined to four days in August from 6 a.m. to 10 p.m. The appreciation of the results also includes an attempt to assess the total "transport effort," i.e. the net ton and passenger mileage carried on the roads of the country, and to compare these figures with the net ton and passenger mileage carried by the railways.

120. As far as the international comparison of census methods is concerned, the principal table appended to the Danish report shows the total road mileage in each of the countries concerned, the mileage of roads covered by the census, the number and average distance of census points, the days and hours of the census, the number of different categories of vehicles or road users included in the census, and the average gross weights used for the computation of traffic weights. It is perhaps surprising to find, in view of the world-wide tendency towards standardization of design, that there are major differences in the assumed unit weights of vehicles such as private motor cars (e.g. 1·2 tons in Italy and 1·6 tons in Holland). In view of their basic differences, comparisons of census results must obviously be subject to many reservations.

121. Among the tabulated census results obtained during the years 1933/35, those from Great Britain show by far the heaviest traffic (an all-round average of 1,848 vehicles per day, excluding bicycles). But this figure relates to Class I Roads only, representing but 15 per cent. of all roads, so that the figure cannot be fairly compared with other countries where a greater percentage of roads was covered. The lowest figures were recorded in Finland, where a census extending over all highways gave an all-round average of 56 vehicles per day. Comparative figures are also given for the average traffic weights per day but, owing to the use of different unit weights already referred to, these figures must be subject to even greater reservations than the traffic figures by numbers of vehicles.

Conclusion

122. Although the length of the foregoing survey may have tried the reader's patience, it can still not claim to be comprehensive. Indeed, in view of the heterogeneous nature and wide dispersal of statistics relating to railways and roads, no single survey of this kind is likely to succeed in covering all aspects of transport statistics and all existing sources. The present survey would, however, have fulfilled its primary purpose if it were able to serve as a first guide to the student who is bent on carrying out further and more thorough research work in the field of transport statistics. The survey may also have shown that, in spite of the excellence of certain statistical

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sources at our disposal, there is still scope for improvements, both in the extent of statistical coverage and in the presentation of the material. In particular, there may be a rewarding task for a statistician who will endeavour to adapt the available railway and road statistics to a pattern showing a more obvious logical coherence, on some such lines as the sketch outlined at the outset of this survey.

123. In the assembly and appraisement of this mass of material, the writer desires to acknowledge the valuable help he has received from his colleague, Mr. E. Rockwell, whose knowledge in particular of foreign sources of information has been of great assistance.

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The Sources and Nature of Statistical Information in Special Fields of Statistics

Oils and Fats Statistics

Contributed by the Economics and Statistics Department of Lever Brothers and Unilever Limited

1. *Introductory*

Oils and fats statistics are still in their infancy, having few of the refinements met in other fields where statistics have been collected and discussed over a long period of years. Some progress is being made, however, and recent improvements are designed not only to meet the requirements of the trade but also, particularly in these days, to assist governments, international agencies, scientists and publicists on questions of nutrition. The importance to health of an adequate supply of oils and fats is now recognized, and many governments watch the level of *per capita* consumption, and take active measures if it is in danger of falling too low.

2. *Definition*

The term "Oils and Fats" is not confined to edible materials, but extends to nearly all oils and fats from vegetable, animal and marine sources; some of these are used entirely for inedible purposes, whilst others can be used in either the edible or the inedible field. The proportions in the industrialized countries are roughly two-thirds edible and one-third inedible usage, but in the under-developed countries the inedible proportion is naturally much lower.

An idea of the coverage can be obtained from the main end-products. On the edible side are included margarine, butter, lard, compound lard, cooking fats, dripping and edible oils for cooking or salads, etc. The principal inedible use is in soap-making, whilst large quantities of drying oils (mainly linseed oil) are needed for paint and linoleum manufacture and for other purposes. It is unnecessary to list all the sources of the fatty materials used in the manufacture of soap, margarine and edible fats, but copra, groundnuts, sunflower seed, cottonseed, palm oil, palm kernels, tallow and whale oil are the principal ones, other important sources being soya beans, rapeseed and olive oil.

Many foodstuffs contain a proportion of fat, but only where this fat is extracted for separate consumption, i.e. where it is in its "visible" form, is it included in the oils and fats statistics. Thus, the fats in milk, cheese, meat and fish consumed as such are ignored; cream is also excluded, though the fat content is high. In some cases the dividing line is hard to draw, and it will be shown that differences in estimates of oils and fats production are sometimes due to this difficulty.

Mineral oils (including synthetic detergents made therefrom) are entirely excluded, also vegetable waxes, volatile vegetable oils (e.g. for use in perfumes) and cocoa-butter (used mainly in the chocolate trade).

3. *Scope*

A review of oils and fats statistics must extend to the international field, where many of the statistical problems arise. Moreover, the United Kingdom is dependent on imports for the bulk of her supplies; out of a world production of oils and fats of around 21½ million metric tons, U.K. requirements are in the region of 1½ million metric tons, of which about 95 per cent. is imported. In this paper, therefore, questions of the measurement of world production and world trade, together with the calculation of available supplies and consumption in particular countries, are first considered in order to provide an adequate background to the more detailed discussion of the U.K. oils and fats statistics.

In the U.K. section the statistics of domestic production, imports and available supplies and of their disposal to the consumer, either directly, or indirectly via manufactured products, are

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traced through, consideration being also given to the lack of data in certain fields, e.g. stocks.

The interpretation and uses of oils and fats statistics form the concluding section of the paper. This brings in several further points such as related statistics, international comparisons and factors involved in forecasting supplies.

4. *International Statistics*

(a) *Production*

In some fields the statistical problem is concerned with methods of breaking down, in others of building up. Oils and fats statistics fall mainly in the latter category, since many of the products are interchangeable and broad classifications are desirable. A manufacturer of soap or margarine can use various combinations of raw materials, whilst in the consumer field margarine and butter or lard and compound lard are to a large extent substitutable. It is useful, therefore, to have figures of production of the various kinds of materials in a form which enables them to be aggregated, and this is done by converting the output of each material to a common standard, namely, the oil content. In this way the total oils and fats production for a particular country or for the world can be quoted in an appropriate and comparable form, and a fall in the production of one material can be measured against a rise in another.

Most of the official statistics of the various countries are still confined to individual raw materials and end-products, and the regular compilation of aggregate production statistics of the types indicated has been a fairly recent development. It was begun in the 1920's by the International Institute of Agriculture (I.I.A.) at Rome, and a systematic study, entitled *Oils and Fats: Production and International Trade* (2 parts) was published in 1939. This work of the Rome Institute has now been taken over by the Food and Agricultural Organization (F.A.O.) of the United Nations, which has recently published a statistical assessment in one of its "Commodity Series" bulletins. The U.S. Department of Agriculture also publishes a regular series of world oils and fats statistics covering the post-war years, with a pre-war comparison. The Unilever organization compiles its own estimate of world production and, though this is mainly for internal use, some of the figures are made public in speeches and articles.

The I.I.A. study stimulated discussion on the basis of compiling these aggregate statistics. Although a most valuable work, there were certain unsatisfactory features, one of which was the failure to make estimates to fill in gaps in the information; for some of the overseas producing countries, for example, exports were treated as equivalent to production, the domestic consumption of oils and fats being ignored. Moreover, the animal fat statistics were sketchy and incomplete. For oil-bearing vegetable crops, the oil content percentage was applied to the whole of the crop, irrespective of whether it was all available for processing into oil or not. Nowadays adjustments, though approximate, are made to exclude the part of the crop likely to be used for other purposes than oil. In the case of annual crops such as linseed, groundnuts and cottonseed, allowance has to be made for seed for re-sowing. Some crops such as copra (coconuts) or groundnuts are partly consumed as food; others, such as cottonseed, are sometimes wasted or are used as cattle food (e.g. India). Soya beans are manufactured into soya flour as well as being converted to oil. It will be apparent that there is room for much difference of opinion as to the deductions to be made under these heads in order to assess "visible" oil and fat production, and this is one of the reasons why there are substantial variations between different estimates of world production.

Although some degree of standardization between these estimates has been achieved, there is still much to be done. The oil equivalents used are not always identical,* "Spek," a pork fat much used in certain European countries, is sometimes included and sometimes excluded. The estimates of the U.S. Department of Agriculture omit the substantial production of ghee, a type of melted butter consumed largely in India and Pakistan. The F.A.O. estimates exclude fish liver oils and inedible oil obtained from sperm whales. For some overseas producing countries the most practicable method of estimating production is by taking exports and adding an estimate

* In order to facilitate comparisons between one country and another, it is usual to adopt, for each oilseed, an oil content percentage which can be applied universally, i.e. a sort of average percentage. But it is not easy to agree as to exactly what this percentage should be, since the actual oil out-turn varies, not only between countries, but even between different mills in the same country. The percentage applied represents the *crude* oil output.

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of domestic consumption (allowing also where possible for any substantial stock movements), and the degree of accuracy obtained depends on whether the estimator is free to make a general judgment from the available data or feels bound to apply rule-of-thumb procedures.

These and other factors inevitably create fairly wide differences in the estimates. This is not the place for investigating these discrepancies, and they are mentioned mainly to illustrate the problems involved. Nevertheless the differences shown by the world production figures given below indicate the need for further study and co-operation in this field.

TABLE 1.—*World Production of Oils and Fats (Oil and Fat Content)*

Metric tons (000)

	Pre-war	1948
U.S. Dept. of Agriculture	19,771*	18,918
Food and Agricultural Organization . . .	23,200†	21,745
Unilever	21,587†	20,931

* 1935–39 average.
† Mainly 1934–38 average.

It will be noticed that the position is further confused by differences in the pre-war averages adopted, a difficulty which is also met in other statistical fields.

The different points at which materials begin to be classed as oils and fats may seem curious, but are explainable. Butter, lard and tallow, for example, are included only as they become available in these "visible" forms, this in view of the wide alternative uses of milk, pig fat and other animal fats. These products are usually processed solely from domestic materials, and can therefore be included in full in the oils and fats production of the country concerned (though occasionally deductions have to be made for any imported materials which have been used). However, such a method is not suitable for vegetable oil-bearing materials, a large proportion of which are grown in one country and processed in another; consequently they are usually included in the production figures (on the basis outlined above) as from the time the crop is harvested.

It will be noticed that production figures are quoted in calendar years. This also raises difficulties, for it is necessary to decide the calendar year in which to include a particular crop.* One basis adopted is to include it in the calendar year in which the bulk of the crop is available for processing, annual oilseed crops harvested up to (say) August being included in production in the same year and crops harvested after August in the next year. Olives, for example, are harvested late in the year, and the estimated olive oil production from the crop is best included in the figures for the next calendar year. With some late crops, however, a reasonable proportion of the crop is crushed in the same year and here an apportionment is desirable. But there are no agreed rules on these matters, and present treatment is not uniform. This is unfortunate, for significant differences in world oils and fats production estimates due to this factor are more apparent than real. For example, the olive crop varies substantially from year to year, and two independent world production estimates may show a wider divergence merely because of a different basis of allocation to calendar years of olive oil production.

Whale oil is a product for which notional rules have to be applied since it is not produced in any country. The basis adopted is to treat it as the production of the country under whose flag the floating factory operates. Accurate statistics of production are published in Oslo by the Committee for Whaling Statistics under the title *International Whaling Statistics*. There are also the various national statistics, though these are frequently unsatisfactory. In some countries whale oil produced in their own factory ships is classified as domestic production, in certain others, e.g. U.K., it is included in the official import statistics, whilst occasionally it is included both as production and imports; care is therefore necessary to avoid counting whale oil production twice, or perhaps omitting it altogether, in computing the available supplies of a particular country. The whaling season begins in November, but very little oil reaches land

* The adoption of crop years instead of calendar years would also raise problems because of the widely differing dates of the various oilseed crops and the need to fit in Southern Hemisphere production.

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by December 31st, so it is classed as production of the succeeding calendar year. Oil is also extracted from other fish, e.g. herrings, but production is naturally counted only as the oil becomes available, and is included (usually on the basis of broad estimates) as domestic output of the country where it is extracted.

It is not usual to attempt to divide world production between edible and inedible oils and fats because of the alternative uses of many of them. Furthermore, the process of refining crude edible oils produces a residue which can only be used for inedible purposes. The division between edible and inedible usage is therefore made for each country separately, and is based on data indicating the actual usage of oils and fats in the manufacture of the various end-products. It is convenient to remark here, however, that the trend of utilization of oils and fats during the present century has been away from inedible and in favour of edible usage. Modern techniques of deodorization, refining, hydrogenation, etc., have permitted many materials formerly classed as inedible to be used in the production of edible oils and fats. A recent development has been the use of mineral products in the manufacture of synthetic detergents, thus reducing to some extent the demand for oils and fats for this purpose.

The degree of accuracy attainable in the various production estimates depends on many factors. Statistics of dairy butter production, for example, are reasonably accurate, whilst figures of farm production of butter are subject to fairly wide margins of error. The international control of whaling permits exact calculations so far as whale oil is concerned, but the production of other marine oils is difficult to assess, since in the under-developed countries the necessary figures are not collected. In a few producing countries, factory statistics of tallow, etc., output are available,, but for most countries estimates of output of "other animal fats," i.e. tallow, slaughter fat, etc., are more in the nature of "informed guesses." The accuracy of vegetable oil production figures also varies from country to country; reasonable accuracy is possible for the production of the more developed countries, but not for many of the under-developed tropical countries; although exports from these latter countries are published, the figure of domestic consumption of oils and fats can only be a broad estimate.

(b) *World Trade*

About 18–25 per cent. of the oils and fats produced enter world trade. For some producing countries the percentage exported is, of course, much more than 25 per cent., whilst Europe, and particularly U.K., is heavily dependent on imports to supplement local production. Statistics of world trade are naturally more precise than those of production, and thus it is possible for aggregate figures computed by various organizations to agree quite closely, subject to any differences arising out of the coverage and the oil content percentage applied.

There are several ways of aggregating world trade, and examples can be seen in F.A.O. Bulletin *Fats and Oils* (Bulletin No. 13 in the Commodity Series, issued August, 1949). The most obvious starting-point from the foreign trade returns of the various countries is the aggregation of the gross imports and gross exports (i.e. including re-exports) of oils and fats (Tables 11 and 12 in F.A.O. Bulletin). The F.A.O. tables are not confined to the primary raw materials, but extend to semi-manufactures, e.g. oil produced from indigenous or imported oilseeds, and to the principal end-products, e.g. the fat content of imports and exports of soap and margarine. The oil and fat content of certain end-products, such as biscuits, sweets, paint and linoleum, is ignored as not being so significant as for soap, margarine, etc.

Gross imports and gross exports are mainly important for the product totals (for the world or by regions) which they provide. The aggregate world figure for all oil and fat products is not of particular significance, since a large measure of duplication is involved owing to the inclusion of imports and exports of oil,* soap, margarine, etc., made from imported oilseeds or other materials. The next step, therefore, is to eliminate duplication and arrive at a net figure. For some purposes all that is required is the net import or net export tonnage for a particular country. But to arrive at a significant "world" figure, exports by each country of indigenous materials (whether as seed, oil or end-products) are totalled, the corresponding figure for imports

* In the F.A.O. figures, whale oil *production* is included *in full* in gross world exports, and the producing country, in so far as it receives its own oil, is included in the table of gross imports as an importer of that oil.

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being obtained by summarizing the retained imports for each country (Tables 13–15 of the F.A.O. study). It will be appreciated that some countries, e.g. the U.S.A., appear in both tables, having exports of certain types of indigenous materials and also retained imports of other types of oils and fats.

(c) *Available Supplies*

There is no exact definition of "available supplies," and the term is used in slightly different senses. For the world as a whole, one can say that production, computed as already described, represents the actual supplies which are available. On this basis, all that is necessary in arriving at available supplies for a particular country is to add imports to production and deduct exports; the sum of available supplies for all countries so calculated should then be equal to world production, subject to the usual differences (due to shipments in transit, etc.) between world exports and world imports. The table below illustrates the calculation on these lines of the available supplies of a particular country—in this case Holland.

TABLE 2.—*Holland. Estimated Total Oils and Fats Supplies (Oil and Fat Content) Metric Tons* (000)

	Average 1933–37	1948	1949*
1. Indigenous production	135	101	126
2. Dutch whaling	—	14	18
3. Imports	367	189	280
4. Exports	227	68	120
5. Apparent supply 1 + 2 + 3 − 4	275	236	304
6. Population (millions)	8·4	9·8	10·0
7. *Per capita* (lb.)	72·2	53·1	67·0

* Based on incomplete data.

Note.—The foreign trade figures include margarine (fat content) but not soap, the imports and exports of which are negligible.

This is a convenient way of computing oils and fats supplies but it has obvious limitations. The oils and fats concerned are certainly "available" in one form or another, but only part of them are available in that year to the consumer, and part of them are not available even as oil but only as oil seeds.* An alternative calculation which gets nearer to the point of availability to the consumer is to compute supplies in terms of the output from the first processing of the original domestic or imported materials. This alters the basis only in respect of oilseeds, etc., from which the oil has to be expressed; instead of calculating the oil content of supplies from the estimated tonnage of oilseeds, etc., available, the actual oil out-turn from the oil mills in the calendar year is taken. The U.S.A. compute their available supplies in this way, as illustrated in Table 3.

This method involves adjustments to the oils and fats import figures. Line 3 (Table 3) excludes the oil equivalent of imported oilseeds, and in its place includes the actual factory production of oils from such imports. Thus imported oilseeds are taken into the calculations only as they become available as oil. There will, of course, be differences between the oil actually processed in a calendar year and the oil content of oilseeds imported in that year, and this will be due mainly to changes in stocks of (unprocessed) oilseeds.†

Adjustments are also necessary in respect of exports of oilseeds from indigenous sources. Until recently it was the practice to exclude these domestic oilseed exports from line 4 (Table 3), the reason being that the table was not concerned with oilseeds as such, but only with the

* The point here is that if available supplies on this basis are changing, the effect will not be felt by the ultimate consumer until a few months later.

† Small differences may also arise from variations between the assumed oil content percentage of imported oilseeds and the actual percentage of oil obtained in processing.

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TABLE 3.—*U.S.A. Oils and Fats Supplies*
Metric Tons (000)

	Average 1937–41	1947	1948 *Preliminary*
1. Production from domestic materials	3,737	4,555	4,767
2. Stocks at January 1st	1,006	574	587
3. Imports of oils and factory production of oils from imported materials	895	618	574
4. Exports, re-exports and shipments to U.S. territories	217	451	446
5. Stocks at December 31st	1,045	587	762
6. Apparent disappearance	4,376	4,709	4,720
7. Civilian disappearance	4,354	4,661	4,671
8. Civilian *per capita* disappearance (fat content)—	*lb.*	*lb.*	*lb.*
Food	46	42	42½
Non-Food	24	27	26
Total	70	69	68½

oil expressed from that seed. But this practice was open to misinterpretation; line 4 might, for example, be quoted out of its context and treated as representing total U.S. oil and fat exports (in terms of oil); this would give a wrong impression, particularly in view of the recent expansion of oilseed exports from U.S.A. In view of these factors, the oil content of oilseed exports is now included in line 4 and also in line 1. Consequently line 1 covers not only domestic production of oils and fats from indigenous materials, but also the oil content of indigenous materials (oilseeds) which are exported in the form of seeds; it therefore gives some indication of the oil equivalent of the whole domestic production of oleaginous materials (excluding the part diverted for purposes other than fat production).

Unfortunately, even this type of statistical data fails to form a bridge between initial production and final consumption: it is more in the nature of an intermediate stepping-stone with unknown elements on both sides. The table gives the impression of an easy transition from production (in the form of oil) to consumption (or apparent disappearance, as it is called), but this is deceptive, as we shall see; and as for the gap in the opposite direction, i.e. between calendar year crop production and calendar year oil output, attempts to make a reconciliation often throw up quite inexplicable differences, differences which might be due to statistical defects, abnormal changes in oilseed stocks on farms,* changes in the proportions of the crop diverted to other uses, or other factors. If these difficulties arise in U.S.A. where the statistical coverage is more advanced than anywhere else, it is obvious that in other countries the forging of a link between production and consumption is an even more hazardous undertaking.

(d) *Consumption*

Consumption of oils and fats by countries can be computed from available supplies by making the necessary adjustments for changes in stocks. Unfortunately, data on stocks are extremely scanty, and figures of available supplies have frequently to be treated as equivalent to consumption, or purely arbitrary assumptions made as to stock changes. This does not matter in assessing long-term trends, but annual consumption estimates can, of course, be thrown badly out. However, when stocks are fairly stable, the annual figures of available supplies give a near approximation to consumption, though estimates are only notionally by calendar years, since the products (as included) are in various stages of the production process. Available supplies based on oil milling statistics, where available, are closer to a calendar year consumption basis, and have the added

* Regular details of factory stocks of oilseeds are available for U.S.A., but not other oilseeds stocks, such as on farms.

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advantage of automatically eliminating changes in the volume of oilseed stocks from the consumption estimates.

Apart from the publication of statistics of creamery stocks of butter by certain countries, the United States is the only country both able and willing to make public their oils and fats stock figures, and even for U.S.A. the coverage is not complete. This lack of information on stocks is, of course, a serious disadvantage, particularly when they are changing, as in 1948. In that year re-stocking was prevalent, and the F.A.O. in estimating consumption by countries (Table 16 of their bulletin) felt obliged to take this into account, as the footnote to the table indicates:

> "In computing the apparent domestic consumption, allowance has been made where possible for changes in stocks. Since such data is not available for the majority of countries it has been necessary to make 'notional' adjustments for the stock replenishment which undoubtedly occurred in most countries in 1948 . . ."

Thus in the case of Holland, the F.A.O. estimated 1948 consumption at 215,000 metric tons, which compares with the Unilever estimate of available supplies previously quoted (Table 2 above) of 236,000 metric tons. Such an estimate of consumption based on inadequate data is subject to possible wide margins of error, and must, as the F.A.O. point out, be regarded as "very provisional."

In the case of U.S.A. an adjustment is possible for "factory stocks" of oil, and the "apparent disappearance" figures (line six of Table 3 above) are after making this adjustment. But there are other stocks for which no adjustments are made, these being, according to the Bureau of the Census of the U.S. Department of Commerce, "stocks in the possession of household consumers,* and stocks held in private storage by retailers, wholesalers and jobbers." Such stocks, known as pipe line stocks, are subject to considerable variation. The pipe lines were at a low level at the end of the war, but became over-filled in later boom conditions and may have declined in 1949 with falling U.S. prices. In some years changes in these "invisible" pipe line stocks may be more violent than changes in the factory stocks, and consequently estimates of consumption on the present basis do not necessarily reflect changes in the buying habits of consumers. It is for reasons such as these that the terms "apparent consumption" or "apparent disappearance" are preferred in referring to these estimates.

It is sometimes possible to estimate consumption from information available on the end-products, such as sales by manufacturers, retail sales, consumer surveys, etc., but the figures so arrived at are rarely reconcilable with estimates based on available supplies. Apart from the reasons already mentioned (stock changes, time lags), the difficulty of computing the part of consumption taking place outside the normal channels of trade or of allowing generally for incomplete coverage in the data means that direct estimates of consumption of end-products are also subject to fairly wide margins of error. However, data on end-products usually give an indication of the proportions in which the various products are sold; a pattern of consumption is therefore discernible, and estimates of total consumption can be apportioned over the end-products on the lines of this pattern. The F.A.O. make (or reproduce) this kind of apportionment (Table 17 of their bulletin) for specified countries, of which the following U.S. figures are illustrative (see Table 4).

The total consumption figure shown is really the "apparent disappearance" (line 6 of Table 3, after adjusting for the fat content of butter). It has already been explained that this is not necessarily equivalent to actual consumption; hence the heading, "Estimated Structure of Consumption."

It is convenient to point out here that butter is included in some aggregates at its full weight, i.e. including its water content. This explains the difference between the 4,570,000 metric tons shown in Table 4 and the 4,720,000 metric tons given in line 6, Table 3. The F.A.O. figure includes only the fat content, whilst the U.S. Department of Agriculture figure includes the full weight of the butter (although the water content is eliminated in calculating the *per capita* figures at the foot of the table). The water content amounts to 129,000 metric tons, so there is no fundamental discrepancy between the two estimates.

* It is probable that variations in stocks held by household consumers are more important than is generally assumed.

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TABLE 4.—*U.S.A. Estimated Structure of Consumption of Oils and Fats by End-products (Fat Content)*

	1948 *Metric Tons* (000)	
Butter	545	
Lard	865	
Margarine	330	
Shortening	635	
Other edible	470	
	—	2,845
Soap	940	
Other industrial	785	
	—	1,725
Total		4,570

5. *United Kingdom*

(a) *General Remarks*

In the 1930's a comprehensive review of the production and consumption of fats in the United Kingdom was contributed by the Unilever organization to the International Institute of Agriculture, Rome, and was published in Part II of their book, *Oils and Fats: Production and International Trade* (Rome, 1939). Although mainly of interest to the trade, this contribution included representative oils and fats statistics (averages 1909–13 and 1924–28, and yearly for the period 1929–36), which involved bringing together figures from several sources and building up a composite picture, gaps in the information being filled in with rough estimates.

To-day the information is somewhat fuller, and most of it is collected in the *Annual Abstract* and *Monthly Digest of Statistics*; nevertheless there are still a considerable number of gaps, and the composite picture still has to be created by combining figures from several of the tables and from the U.K. foreign trade returns. It should be remembered, therefore, that most of the tables given in this section of the paper, though based mainly on official statistics, have no official validity in themselves. The figures presented cover the year 1948, and are designed to show some of the problems involved in assembling the data and in forming a connecting link between the various stages of oils and fats production and utilization. Metric tons are quoted throughout, except where otherwise stated.

TABLE 5.—*United Kingdom. Estimated Total Oils and Fats Supplies (Oil and Fat Content)*

Metric Tons (000)

	Average 1934–38	1948	1949
Indigenous production (excluding whale oil)	160	73	84
Imports less re-exports—			
Whale oil from British whale fisheries	64	98	106
Other imports	1,353	1,203	1,380
Exports (including the fat content of soap)	171	49	55
Apparent supply	1,406	1,325	1,515
Population (millions)	47·1	50·0	50·4
Per capita (lb.)	65·8	58·4	64·0*

* Assumes some additions to stocks.

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(b) *Official Statistics*

It will be convenient to begin with the official statistics (other than foreign trade) for 1948, numbering the items for later reference. They are taken from the *Annual Abstract of Statistics, 1938–48*, and most of the items also appear in the *Monthly Digest of Statistics*.

	1948	
	English tons (000)	*Equivalent in metric tons* (000)
Seed Crushing—		
1. Oilseeds and nuts processed	989	1,005
2. Crude oil produced	452	459
Vegetable Oil Consumption (crude oil basis)—		
3. Total disposals	842	856
4. Total disposals for food	531	540
Whale, Herring and Seal Oil Consumption (crude oil basis)—		
5. Total disposals	145	147
6. Total disposals for food	131	133
Production of Animal Fats—		
7. Lard	1	1
8. Other edible fats	36	37
Production of Milk Products—		
9. Butter (excluding farmhouse) (product weight)	8	8
Production of Compound Edible Fats—		
10. Margarine (product weight)	407	414
11. Compound cooking fat	183	186
Consumption—Dairy Products—		
12. Butter (product weight)	278	282
Consumption—Fats—		
13. Margarine (product weight)	409	416
14. Lard and compound cooking fats	184	187
Crops Harvested—		
15. Linseed	35	36
Food Supplies Per Head of Civilian Population—	*lb. per head*	
16. Butter	12·5 (product weight)	
17. Margarine	17·5	,,
18. Lard and compound cooking fats	7·9	
19. Other edible oils and fats	5·0	

The above covers practically all the primary data available, though reference to some official aggregates will be made later. A summary of imports and exports is given in Table 5.

(c) *Available Supplies and Foreign Trade*

Table 5 gives a Unilever estimate of U.K. available supplies, based on local production plus the fat content of net imports.

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Although only the 1948 figures are being considered in this paper, the figures for 1934–38 and 1949 may also be of interest in showing the comparative position. The table is one of a series compiled by Unilever for several countries and, in computing the fat content of oilseed imports, a standard percentage has been applied so as to ensure comparability between available supply totals for each country. This, as explained later, produces a slight understatement of actual U.K. supplies in terms of fat content.

Official calculations of available supplies of oils and fats are contained in the Ministry of Food Bulletin of January 21st, 1950. This is the first issue to be released to the public, previous issues being for official use only. Tables of total supplies comprise:

(*a*) Butter (product weight)

and (*b*) Oils and fats (crude oil equivalent basis).

The latter table includes oilseeds and nuts, vegetable oils, marine oils and animal fats, and in both tables total imports (by main countries of origin) and total home production are shown separately. The 1948 totals with metric ton conversions are as follows:

TABLE 6.—*United Kingdom. Oils and Fats Supplies*—1948

	English tons (000)				*Total equivalent in metric tons* (000)
	Butter (product weight)	*Butter (fat content 84%)*	*Oils and fats*	*Total (fat content)*	
Imports	273	229	972	1,201	1,220
Home production	16	14	128	142	144
Total supplies	289	243	1,100	1,343	1,364

The Ministry's table is not in sufficient detail to permit a reconciliation with the Unilever estimate in Table 5, but some of the differences are due to the following factors:

(i) The official percentages of crude oil equivalent applied to imports of oilseeds* are somewhat higher in some instances than the Unilever percentages, and may reflect more exactly the U.K. oil out-turn experience.

(ii) In the official calculation of total supplies no deduction is made for the fat content of soap exports.

(iii) Home production, though appearing to be larger than the Unilever estimate, is actually smaller, since the official estimate of 144,000 metric tons includes whale oil from British whale fisheries; on a comparable basis, the Unilever estimate is 171,000 metric tons.

Too much significance should not be attached to these differences, as it is probable that the Ministry's tables are intended to be no more than a general guide to sources of U.K. supplies of various products.

In due course a closer measure of agreement may be possible between private estimates and the M.O.F. calculations. The present exposition, however, will be developed from the Unilever estimate of available supplies in Table 5, the next step being the analysis of the foreign trade figures shown in the table. It has been necessary in this analysis to set out the figures in some detail for the purpose of tracing subsequent movements in the various types of oils and fats. Line numbers have been continued for these items to facilitate cross-reference, and all figures have been converted to metric tons.

* The official percentages are given in the Definitions and Explanatory Notes Supplement to the *Monthly Digest of Statistics* (page 36 of January, 1950 edition). They are given below for purposes of reference:

Cottonseed	17%	Linseed	33%
Groundnuts decorticated	46%	Rapeseed	38%
" undecorticated	31%	Sunflower seed	26%
Copra	63%	Castor seed	44%
Palm kernels	47%		

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TABLE 7.—*Summary of U.K. Foreign Trade in Oils and Fats*—1948

Metric Tons (000)

	Classification in U.K. Foreign Trade returns	*Actual weight*	*Oil equivalent*	
Gross Imports—				
20. Oilseeds and nuts	IIJ	1,024	432	
			—	432
Oils and fats:				
21. Vegetable	IH, IIJ	423	423	
22. Whale* (excl. sperm)	IIJ	124	124	
23. Other fish (incl. sperm and herring oil)	IIJ	26	26	
24. Tallow—unrefined	IIJ	29	29	
25. ,, refined	IH	35	35	
26. Sundries	IH	4	4	
			—	641
Total raw materials (oil equivalent)				1,073
27. Butter	IE	277	233	
28. Margarine and soap	IIE, IIIP	Negligible	—	
29. Lard	IH	10	10	
			—	243
Total gross imports (oil equivalent)				1,316
Re-exports—				
30. Butter	IE	3	3	
31. Vegetable oils and fats (unrefined)	IIJ	12	12	
			—	
Total re-exports (oil equivalent)			15	15
Exports—				
32. Oils and fats—refined	IH, IIJ	11	11	
33. ,, ,, unrefined	IIJ	12	12	
34. Margarine	IIE	7	6	
35. Compound lard (shortening)	IH	3	3	
36. Soap	IIIP	28	17	
			—	
Total exports (oil equivalent)			49	49

Source.—Official statistics; oil equivalents are Unilever estimates.

* This includes arrivals of whale oil from British whale fisheries—98,000 metric tons.

(d) *Domestic Production*

The Unilever estimate of domestic production (see Table 5) is made up as follows (see Table 8):

The numbers in brackets against certain items in Table 8 and subsequent tables refer to official statistics, etc., already quoted. Farmhouse butter production is an estimate, but the combined dairy and farmhouse production (16,000 metric tons product weight) agrees with the figure adopted by the Ministry of Food (Table 6). For lard, a slightly higher figure has been taken than in the official estimates (line 7), although it still seems rather low in relation to pig slaughterings. Fish oil and inedible tallow are Unilever estimates, no official figures being published. The figure for edible tallow is an estimate of production from domestic materials only, as the figure given in the official statistics (line 8) for production of other edible animal fats is not confined to production from domestic materials but includes some processed imports.

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TABLE 8.—*United Kingdom. Domestic Production of Oils and Fats*—1948

Metric Tons (000)

	Actual weight	*Oil equivalent*
Dairy (creamery) butter (9)	8	7
37. Farmhouse butter	8	7
38. Lard	2	2
Linseed (15)	36	11
39. Fish oil	5	5
Other animal fats (tallow, slaughter fat):		
40. Edible (say)	25	25
41. Inedible (say)	16	16
Total domestic production (oil equivalent)		73

(e) *Edible and Inedible Usage*

The data on disposals of vegetable oil and whale, herring and seal oil given in the official statistics (lines 3–6) show separately the amount allocated for food, and thus enable an estimate to be made of edible and inedible usage of oils and fats. Supplies computed on this basis are

TABLE 9.—*United Kingdom. Available Supplies Based on Oil, etc. Disposals with Division Between Edible and Inedible Usage*—1948

Metric Tons (000) *in terms of oil or fat*

	Edible	*Inedible*	*Total*
Vegetable oil disposals (crude oil basis) (3) (4)	540	316	856
8 per cent. estimated refining loss to inedible	−43	+43	—
	497	359	856
Whale, herring and seal oil disposals (crude oil basis) (5) (6)	133	14	147
3 per cent. estimated refining loss to inedible	−4	+4	—
	129	18	147
Oils omitted from official statistics (imports)	5	29	34
Total oils	631	406	1,037
Butter disposals (incl. farm)	244	—	244
Lard (imports plus domestic production) (29) (38)	12	—	12
Imports of tallow (24) (25)	35	29	64
Domestic tallow production (40) (41)	25	16	41
Sundry oil and fat imports (26)	4	—	4
Total gross supplies	951	451	1,402
Deduct—			
Re-exports (oil equivalent) (30–31)	3	12	15
Exports ,, ,, (32–36)	20	29	49
Net available supplies (based mainly on disposals for domestic consumption)	928	410	1,338

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nearer to the point of availability to the consumer, since they represent the oil actually delivered for further manufacture into end-products.* The data also afford the opportunity of trying to trace the various statistics through, from home production plus imports, via the official seed-crushing statistics (lines 1 and 2), to the oil disposals.

In Table 9 "disposal" figures are used wherever available, but for a few types of fat (mainly lard† and tallow) disposal figures are not available, so imports plus domestic production are inserted to complete the picture. The result is a total figure which does not differ materially from available supplies computed as the sum of net imports and home production (Table 5), though this would not necessarily apply in other years, e.g. in years when there were large changes in stocks of oils and seeds.

A few remarks on some items in Table 9 may be helpful. Firstly, the transfer of the estimated refining loss from edible to inedible usage represents the oil residues from refining, the major part of which are available for use in the inedible field.‡ Secondly, there is the item for oils omitted from the official statistics of oil disposals; these oils include tung oil, stillingia oil, olive oil and sperm oil and, in the absence of disposal figures, import tonnages have been taken (included in vegetable and fish oil imports, lines 21 and 23 in the foreign trade summary: see also Tables 12 and 13). Thirdly, it is necessary to explain that exports and re-exports are deducted at the foot of the table because they are included in disposals but do not represent domestic supplies; exports of end-products (fat content) are clearly provided out of oil disposals to manufacturers, whilst exports and re-exports of refined and unrefined raw materials will be included in disposals in lines 3 and 5 (see definitions in Statistical Abstract).

The statistics in Table 9 permit a comparison of imports and domestic production with oil and fat disposals. Here is a simple comparison for butter:

TABLE 10.—*United Kingdom. Comparison of Butter Supplies and Disposals*—1948

Metric Tons (000)

	Product weight	*Fat content 84%*
Domestic production: Dairy (9)	8	7
Farmhouse (37)	8	7
Imports (27)	277	233
Total supplies	293	247
Disposals (excluding farmhouse) (12)	282	237
Presumed disposals—farmhouse	8	7
Total disposals	290	244

This comparison suggests that there were no significant changes in butter stocks held by controls, though no stock figures are published, and there is therefore no check on the accuracy of the figures. Total disposals are presumed to include disposals for re-exports (line 30—3,000 metric tons), so that butter disposals for domestic consumption were 287,000 metric tons (product weight), 241,000 metric tons (fat content).

The comparison of imports and domestic production of vegetable oils and oilseeds with vegetable oil disposals is more complicated owing to the intermediate processing of the oilseeds. A comparison for the oilseed processing is as follows:

* See paragraph 10 of the introduction to the *Annual Abstract of Statistics*, 1934–38. "Figures given under the headings of 'consumption' or 'total disposals' are usually derived from statistics of releases from stocks by controls or manufacturers and include the amount delivered for export or re-export."

† Disposal figures are available for lard and cooking fats together, but not for lard separately.

‡ The refining loss percentages are Unilever estimates. A small part of the residues are lost in processing, so that the addition to inedible usage is slightly overstated.

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TABLE 11.—*United Kingdom. Comparison of Oilseed Supplies with Oilseed Processing (with Oil Equivalents)*—1948

Metric Tons (000)

	Weight of oilseeds	*Oil equivalent or oil out-turn*
Oilseed imports (20)	1,024	432
Home-grown linseed* (15)	36	11
Total oilseed supplies	1,060	443
Oilseeds processed (1) (2)	1,005	459

* This is the only important domestic oilseed crop, though small quantities of rapeseed, etc., are produced.

No conclusions can be drawn from the above figures as to changes in oilseed stocks, and stock figures are not published. It is assumed in calculating total oilseed supplies that all seeds imported into U.K. are processed for oil, but small quantities are probably diverted to other uses, e.g. soya beans to soya flour and (in normal times) some undecorticated groundnuts for consumption as nuts.

The oil equivalent of total oilseed supplies above is a Unilever calculation based on standard percentages applied in calculating world production or world trade in oilseeds. As already mentioned, the use of these standard percentages arises out of the desire to make the figures for one country comparable with those for another country. They do not necessarily agree, however, with the actual oil out-turn percentages in a particular country, and for the United Kingdom they tend to result in an understatement of actual supplies (as oil). This is obvious from the above table, though no exact comparisons can be made, since the oilseeds processed are not wholly the same as are included in oilseed supplies; the time-lag between importing and processing might in fact distort such oil out-turn comparisons if the proportions of the various oilseeds were different.*

The next step is to compare total oil supplies with oil disposals:

TABLE 12.—*United Kingdom. Comparison of Vegetable Oil Supplies with Disposals*—1948

	Crude oil Metric Tons (000)
Vegetable oil supplies from processing of oilseeds (2)	459
Imports of vegetable oil (21)	423
Total vegetable oil supplies	882
Vegetable oil disposals (3)	856
Add imports of certain oils not included in above disposals:	
Tung oil	13
Stillingia oil	5
Olive oil	5
Presumed total disposals	879

The imports of tung oil, stillingia oil and olive oil form part of vegetable oil imports in line 21 of foreign trade summary, but these products are understood to be excluded from the official figures of vegetable oil disposals. Here again there is no guarantee in the absence of stock figures that differences between supplies and disposals represent stock movements.

To complete the picture it is necessary to give a similar table for marine and fish oils.

* The oil content of oilseeds (U.K. official percentages) varies from 17% (cottonseed) to 63% (copra); see earlier note.

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TABLE 13.—*United Kingdom. Comparison of Marine and Fish Oil Supplies with Disposals*—1948

	Crude oil *Metric Tons* (000)
Imports of whale oil (incl. from British fisheries) (22)	124
Imports of other fish oils (including sperm and herring oil) (23)	26
Domestic production of fish oil (39)	5
Total supplies	155
Whale, herring and seal oil disposals (5)	147
Imports of item excluded (sperm oil)	11
Presumed total disposals	158

The differences thrown up in Tables 10 to 13 (in thousand metric tons $-3+16-3+3=13$) reconcile available supplies computed from home production plus net imports (Table 5) with available supplies based on oil, etc., disposals (Table 9). The main factor in this net increase of 13,000 metric tons is the oil "bonus" obtained, as compared with international standards, owing to the better U.K. oilseed processing technique. The remaining differences are small, but it is doubtful whether the figures are sufficiently accurate to warrant any firm conclusions on the extent of the stock changes, though the data do suggest that such changes cannot have been very large.

(f) *The Structure of Consumption by End-products*

Available supplies based on disposals are composed partly of finished products (mainly butter and lard), the remainder being represented by refined and unrefined oils and fats, most of which are manufactured into end-products such as margarine, cooking fats and soap. It is now desired to apportion edible and inedible usage in Table 9 over the actual end-products. The object of the apportionment is to get as near as possible to actual consumption, and where both production and disposal figures are available the disposal figures will be used. It will be remembered that disposals include exports and re-exports, and these will have to be deducted in arriving at disposals for domestic consumption.

The main end-products on the edible side are butter, margarine, lard and cooking fat, though some refined oils go into direct consumption or are used in the manufacture of biscuits, cakes, etc. Butter disposals have already been considered, and we now turn to the data on margarine, lard and cooking fats.

The following figures illustrate the information available on margarine:

	1948 *Metric Tons* (000)
Oils used in margarine manufacture	345
Margarine production (10)—414,000 metric tons at 84% fat content	348
Margarine disposals (13)—416,000 metric tons at 84% fat content	349

The statistics of oils used in manufacture are taken from the publications of the Commonwealth Economic Committee*; they clearly represent factory consumption of oils in manufacture, and the tonnage shown is not necessarily equal to the tonnage of oil made available to margarine manufacturers as part of oil disposals in lines 3 and 5. (No breakdown of these oil disposals is published.)

The comparison between production and disposals of margarine suggests that changes in 1948 in margarine stocks held by controls were insignificant, though no stock figures are published.

* *Intelligence Bulletin*, Volume I, No. II, April, 1949.

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Similar information on lard and compound cooking fats is as follows:

	1948 *Metric Tons* (000)
Oils used in manufacture of compound cooking fats . . .	184
Actual production of cooking fat (100% fat) (11) . . .	186
Add Domestic production of lard plus imports (29) (38) . .	12
Available supplies lard and compounds	198
Disposals lard and compounds (14)	187

The figures here suggest some additions to stocks in the hands of controls.

An approximate picture of the structure of edible consumption by end-products, based on disposals, can now be obtained.

TABLE 14.—*United Kingdom. Structure of Consumption of Edible Oils and Fats by End-products (Fat Content)*—1948

Metric Tons (000)

	Disposals	*Exports and re-exports*	*Apparent domestic consumption*
Butter (incl. farm)	244	3	241
Margarine	349	6	343
Lard and compounds	187	3	184
Balance—mainly other edible usage			160
Total edible usage (per Table 9)			928

The balance of 160,000 metric tons, though it represents mainly other edible usage, also sweeps up the various differences, stock movements, time lag effects, etc. There is no way at present of verifying and analysing this other edible usage, but most of it is employed in the manufacture of cakes, biscuits, sweets, shredded suet, etc., and in fish and chip frying. The booklet *How Britain was Fed in Wartime* (H.M.S.O., 1946) contains in Appendix B details of allocations of oils and fats for the preparation of manufactured goods, 1942–44, and the total allocations, excluding butter and margarine, totalled 200,000–220,000 English tons a year. As a guess, it is possible that about half these allocations were lard and compounds, the other half refined oils and fats. There is, of course, some direct usage of edible fats and oils (other than margarine, lard and compounds) in the form of dripping, olive oil, etc.

Per capita supplies of edible oils and fats on the above basis work out at about 41 lb. This compares with about 38 lb., based on official figures (Table 185, *Annual Abstract*).

Butter	12·5 lb.	= 10·5 (fat content)
Margarine	17·5 ,,	= 14·7 ,, ,,
Lard and compounds . .	7·9 ,,	= 7·9
Other edible oils and fats .	5·0 ,,	= 5·0
Total		38·1 lb. per head.

It is not clear how far the Ministry's *per capita* figure of 5 lb. for other edible oils and fats is intended to be comprehensive, and it is here where most of the difference lies. Some of the difference may, of course, be due to the stock changes, time lags, etc., already mentioned, e.g. the apparent increases in year end lard and compound lard stocks.

A reconciliation of the edible oil and fat consumption with civilian rationing scales is not possible owing to lack of data on manufacturers' allocations. About two-thirds of available oil and fat supplies were needed in 1948 to meet the civilian rations, but no details are published

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of allocations in that year for manufacturing or to caterers, institutions, etc. A M.O.F. Press Notice of February 14th, 1950, however, gives details of the new allocations of fat for biscuits and cakes, and perhaps in the future more comprehensive information on oil and fat allocations will become available.

No official statistics are published of the utilization of inedible oils and fats in end-products. The Commonwealth Economic Committee, however, in a booklet, *Vegetable Oils and Oilseeds* (H.M.S.O., 1948), give figures on page 98 of oils and fats used in soap-making for the years 1937–46, and later figures will no doubt be published in due course in the Committee's bulletins. Pre-war utilization in soap-making was about 300,000 metric tons, and for 1948 can be put at about 250,000 metric tons. These tonnages have to be adjusted for the fat content of soap exports, which for 1948 totalled 17,000 metric tons, leaving 233,000 metric tons as utilization for domestic soap supplies.* Since total inedible usage has been calculated (Table 9) at 410,000 metric tons, utilization in paint, linoleum, steel-making (palm oil), textiles, greases and lubricants, candles, etc., works out at 177,000 metric tons. Here again the reminder must be given that this figure of 177,000 metric tons sweeps up unknown changes in stocks in all inedible forms.

It is now possible to compare the structure of consumption (edible and inedible) based on the above data with the F.A.O. estimates in their Fats and Oils Bulletin of August, 1949. In comparing the figures, it must be remembered that the division of inedible usage is somewhat arbitrary, and that considerable differences in the apportionment are to be expected.

TABLE 15.—*United Kingdom. Structure of Consumption*—1948

Metric Tons (000)

	Based on preceding figures	*F.A.O.*
Butter	241	228
Margarine	343	340
Lard	12	17
Shortening	172	170
Other edible	160	120
Edible usage	928	875
Soap	233	270*
Other industrial	177	155
Inedible usage	410	425
Grand total	1,338	1,300

* The F.A.O. in a footnote state that the U.K. soap figure probably includes sales by fat splitters other than for soap-making.

Finally, there is the point that this calculation of the structure of consumption by end-products is based on disposals to the trade, which may not be the same as disposals to the final consumer. Generally, however, it can be assumed that rationing will have resulted in fairly level stocks being carried by wholesalers and retailers, and that the end-product figures will approximate to actual consumption. This, of course, does not necessarily apply to "other edible" and "other industrial" usage, which, being residual figures, incorporate certain unknown changes in stocks held by controls and manufacturers.

(g) *Prices*

During and since the war, oils and fats in the United Kingdom have been subject to official buying and control, and prices to manufacturers and large wholesalers are fixed by the Ministry of Food, details being issued in periodical press notices. These official prices are widely quoted

* Soap imports are negligible.

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in journals such as *The Economist* (Statistical Supplement) and *The Statist*, and also in "trade" publications such as the *Public Ledger* (daily) and the *Paint, Oil & Colour Journal* (weekly). If comparisons of prices over several years are desired, brokers' reviews, e.g. the annual review of Messrs. Frank Fehr & Co., are useful. Incidentally, there are no official prices for oilseeds, since the Ministry has the oilseeds crushed *à façon* by U.K. oil mills and sells only the oil.

The basis of the M.O.F. prices is not known. Although total purchase costs will no doubt be recovered in the prices charged, this does not necessarily apply to particular materials, the prices of which appear to be fixed broadly by reference to costs as a whole, and do not necessarily reflect the cost of a particular oil. The actual prices paid by the Ministry are not published, though information often becomes available of agreed prices under annual or long-term contracts. An idea of the average prices paid can, of course, be obtained by calculating from the foreign trade returns the average c.i.f. cost of imports.

No index is available of average movements of U.K. prices for oils and fats as a group. A group index of wholesale prices of oils and fats in U.S.A. is published by the U.S. Department of Agriculture, but it should be remembered that any semblance of a world parity in oils and fats prices has been destroyed by the war, and that generally speaking dollar markets have their own price levels, which since 1948—and even after devaluation—have been lower than in soft currency markets.

6. *Interpretation and Uses: Related Statistics*

The value to the trade of accurate oils and fats statistics needs no emphasis, and the brief comments here are confined to their wider uses, mainly in international comparisons and on questions of nutrition. The reports of the Organization for European Economic Co-operation illustrate this wider use, various statistics being collected in order to assess the progress of European recovery and to fix a target for future years. The improvement of oils and fats supplies is an important part of the programme, and in an early report (July–Sept., 1947, volume II, *Technical Reports*) the following tables are set out:

Appendix C IV (*b*)—Total production of fats (oils from oilseeds, butter and animal fats, including whale oil).
Appendix C IV (*c*)—Production of butter.
Appendix C V (*d*)—Import requirements for fats and oils.

The tables cover all O.E.E.C. countries and Western Germany, and give statistics for 1934–38, 1945–46 and 1946–47, together with the estimated programme for later years up to 1950–51. Some of the figures in these tables have since been amended, but later information is not so comprehensive.

International comparisons of *per capita* consumption of oils and fats provide a useful perspective; the example given below is taken from the F.A.O. Fats and Oils bulletin of August, 1949 (page 5).

TABLE 16.—*Visible Fats and Oils: Pre-war* (1934–38) *World Production and Consumption (Oil and Fat Content)*

Metric Tons (000)

	Indigenous production	*Net imports or exports*	*Apparent consumption*	*Percentage of world population*
Countries with high fat consumption (27 kg. = 59 lb. or more)—mainly U.S.A., Australasia and Western Europe	5,745	+3,035	8,780	14%
Countries with medium fat consumption (10–27 kg. = 22–59 lb.)	5,125	+360	5,485	17%
Countries with low fat consumption (below 10 kg. = 22 lb.)	12,330	−3,395	8,935	69%
	23,200	.	23,200	100%

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The precariousness of the fat supply position for Western Europe (the main importer in the high fat consumption group) is obvious from the table. The supplying centres fall mainly in the low fat consumption group, and even a small increase in their *per capita* consumption, if uncompensated by higher production, could severely cut European supplies. This, of course, has happened to some extent during and since the war, although the shortage of oils and fats in Europe has been due not only to the decline in export supplies from the Far East, but also to lower production of butter and other animal fats in Europe.

Figures of *per capita* consumption are useful in giving a broad picture, but do not necessarily provide a precise comparison of nutritional standards. The figures include both edible and inedible usage of oils and fats, and since inedible usage is higher in the more developed countries, nutritional differences are not quite so pronounced as the table suggests. But even if a similar table giving edible fat consumption was available, it would still have to be related to general nutritional levels. It would then be found, for example, that the rise since pre-war in the *per capita* consumption of oils and fats in the Far East was due partly to lower supplies of cereals, particularly of rice. Furthermore, information on "visible" fat consumption as shown in the above table would require to be supplemented by information on fat consumption in an "invisible" form. Changes in "invisible" consumption during and since the war have been considerable. In the Far East there has been a wider use of fresh coconuts and groundnuts as food, and this has occurred in addition to the rise in "visible" fat consumption. In the United Kingdom the lower *per capita* supplies of "visible" fats, e.g. butter, have been offset to some extent by a larger consumption of fresh milk.* In Western Germany, on the other hand, much of the milk is skimmed in order to permit a high level of butter production, so that "visible" supplies are raised at the expense of a reduction in "invisible" fat consumption.

Related statistics are partly concerned with ancillary businesses such as the manufacture and sale of cattle cake (made from the residues from oilseed crushing) and partly with the longer term aspects of oils and fats supplies. In assessing future trends, data giving "advance information" will be watched. In the case of annual oilseeds, statistics are available in many countries of planting intentions or estimated acreages, then, later on, of the actual areas planted and, finally, various crop estimates up to the time when the actual crop out-turn is known. (It is possible to estimate the cottonseed available from estimates of the cotton crop.) For perennial crops, such as olives, copra, palm oil and palm kernels, monthly figures of exports with comparison for the same period in preceding years give some indication of trends; data on new plantations, post-war rehabilitation of old plantations and weather conditions (frost, typhoon damage, etc.) are also useful.

Livestock population statistics, if they become available without undue delay, give indications of trends in animal fat supplies for some time ahead, since a rise in the livestock population does not immediately affect animal fat supplies from slaughterings. The feeding-stuffs situation is also a useful pointer; it is found, for example, that a plentiful supply of maize in U.S.A. usually results in more pigs being reared, and vice versa.

One final point. The avoidance of delay in compiling and issuing official statistical material on oils and fats is of great importance to the trade. The buyer must always be making some assessment of potential future supplies, and the marketing man, too, must be as up-to-date as possible in his information and outlook. Accuracy is, of course, important, but where it involves delay in the publication of the final statistics the earlier issue of provisional information, though clearly subject to correction and refinement, is a vital consideration.

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* See note on this point at the foot of page 3 of Cmd. 7842 (*Food Consumption Levels in United Kingdom*).

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The Sources and Nature of Statistical Information in Special Fields of Statistics

The Housing Statistics of Great Britain*

By Marian Bowley

I. Introduction

The housing statistics of Great Britain have been greatly improved during the last 40 years, both in scope and accuracy. There are still, however, serious gaps, while the improvements in accuracy which have been brought about to a large extent through refinements of definition and classification necessarily make comparison over time somewhat difficult. An additional difficulty is caused somewhat gratuitously by differences in methods of collection and tabulation between the Scottish statistics and those for England and Wales. It is pleasant to be able to relate, however, that the post-war Scottish statistics have been brought more closely into line with those for England and Wales.

The most important sources of statistical data concerning houses are all official, for it is beyond the powers of private investigators to carry out housing investigations on an adequate national scale. The most important Government Departments concerned are the Ministry of Health for England and Wales, the Department of Health for Scotland and the Ministries of Labour and of Works. The unofficial sources of original statistical data are mainly confined to the various local social surveys, such as those of London, Merseyside and Southampton. It is impossible within the scope of a single article to discuss these latter or even the former in detail for the period before the first world war. Moreover, owing to the local character of the private investigations and differences in methods and definition, these are chiefly of interest to investigators concerned with particular areas.

The official statistical data since 1914, to which this article is thus mainly confined, can be grouped either according to source, or according to subject. While the former method has the advantage of simplicity of arrangement, the latter is probably more useful to the student of housing who wants to know how to find information about some particular housing problem. For this reason I have adopted the latter, although it involves some duplication and cross-references. The chief sets of statistical data are discussed under the following heads:

The Number of Houses, Changes in Numbers and New Houses.
Housing Needs.
Finance and Rents.
Building Costs and the Building Industry.

A word of explanation is perhaps necessary about the use of the word "house." Although not strictly correct, it has come to be used so as to include flats and maisonettes in many contexts. This is so much more convenient that I have followed the popular practice throughout, except where for some special reason it is necessary to refer separately to the various species of dwellings. I hope that where the differentiation is necessary the meaning of the terms is clear from the context.

II. The Numbers of Houses

(a) *The Census Records*

Scope of Data

Complete records of the numbers of private houses are obtained only once in 10 years as part of the information collected in the Population Census. The accuracy of these records has been greatly improved since the beginning of this century by greater precision in the definitions

* This article has been limited to Great Britain as the differences in conditions in N. Ireland, the character of the housing problems, policy and standards have necessarily led to differences in the scope and methods of presentation of housing statistics. Description of N. Ireland housing statistics thus requires a specialized knowledge not possessed by the author of this paper.

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used in successive censuses. These are described in some detail below, as however desirable in themselves, such improvements always introduce certain difficulties into comparisons. The Population Censuses provide a great deal of information not obtainable from any other source, besides the mere total number of houses. For instance, houses are classified according to the number of rooms, the number of people and families occupying the houses of different sizes, densities of occupation per room, etc. Since 1911 the numbers of private houses unoccupied have also been recorded. Most of this important information is available for the smallest Local Authority housing areas, i.e. the rural districts in England and Wales and the county districts in Scotland. Apart from the usual difficulties associated with changes in boundaries of local authority areas, there are no particular troubles involved in using the local as distinct from the national statistics.

In addition to the ordinary census volumes, all the important housing statistics from the 1931 Census for England and Wales were collected together in a separate *Housing Volume* published in 1935. This volume provides a most important source of housing statistics, and contains a most useful account of the character and meaning of the data as well as of the problems of inter-censal comparisons. It also includes some special studies, e.g. on multiple occupation of dwellings, not dealt with in detail in other volumes.

Definitions

The census definitions of dwellings (houses and flats, etc.) and of private families are probably the two connected with housing which have given most trouble. Since they are vital to the usefulness of the census housing data they are discussed in some detail here. Their importance is due to the fact that in order to obtain a definition of private dwellings (houses and flats, etc.) it is first necessary to define a dwelling and then to define a private family, for obviously a private dwelling is one normally occupied by a private family.*

Up to 1911 the count of dwellings was most unsatisfactory, for houses divided into flats, and even blocks of flats, were returned simply as single dwellings. In the 1911 Census, by the use of detailed descriptions of buildings, it was possible to record each flat and maisonette as well as single houses, and also to make an approximate distinction between those in occupation by private families and others. This involved an attempt to define a private family—a definition which it is convenient to discuss a little further on. Greater precision was given to the count of dwellings (houses and flats, etc.) by the introduction in 1921 of the "structurally separate dwelling" as the basic unit in census records. It was defined so as to conform with the ordinary meaning attached to a house, flat or maisonette as follows:

> A structurally separate dwelling is "any set of rooms, intended or used for habitation, having access either to the street or to a common landing or staircase" . . . "each flat in a block of flats is a single unit; a house which has not been structurally subdivided is similarly a single unit whether occupied by one family or several. But where a private house has been subdivided into maisonnettes or portions, each having its front door opening on to the street or on to a common landing or staircase to which visitors have access, then each such portion is a single unit."

The division of the dwellings into private and other depends, it has been explained, on a definition of private families. This required a distinction between the separate occupiers who make census returns and who constitute private families, and those who are not private families in any normal use of the term. The definition introduced in the 1911 Census classed private families as covering all persons not enumerated in—

> (*a*) Military and naval barracks, workhouse establishments, hospitals, lunatic asylums, prisons and certified reformatory and industrial schools, etc.
>
> (*b*) In other establishments including private households of which the number of inmates exceeded 15.
>
> (*c*) On board vessels.
>
> (*d*) In barns, sheds, caravans, etc,, or in the open air.

* A useful history of these and other definitions is given in the *Housing Volume* of the 1931 Census, op. cit., chap. 1.

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The weakness of the definition was self-evident. The list of institutions was not comprehensive enough, while the exclusion from the private family category of private households containing more than 15 people was capable of leading to queer and rather unnecessary anomalies. Thus an old-fashioned family containing, say, two parents, an aunt, four resident servants and seven children at one census would be classed as a private family, while if at the next census there happened to be an additional relative, servant or child in the household, it would cease to be a private family. Another difficulty arose with lodging or boarding houses; for instance, if a man and wife ran a lodging house with 13 lodgers this would count as a private family, but not if the man and wife had a child, as this would have brought the total above 15 persons. It is always difficult to draw a line in this type of case, but in conjunction with the exclusion from private families of any normal private family containing more than 15 persons, the result of the distinction seemed absurd. The revised definition introduced in the 1921 Census and retained for the 1931 Census, though still in trouble with lodgers, was a great improvement. It ran as follows:

> "Any person or group of persons included in a separate return as being in separate occupation of any premises or part of premises is treated as a separate family for census purposes, lodgers being so treated only when returned as boarding separately and not otherwise. Private families comprise all such families with the exception of those enumerated in (1) institutions or (2) business establishments or boarding houses in which the number of the resident trade assistants or resident boarders exceeds the number of the members of the employer's or householder's family (including private domestic servants)."

From 1921 onwards any structurally separate dwelling normally occupied by one or more private families so defined was classed as a private dwelling or private house in the ordinary sense. Even with the aid of these amendments the private family according to the census is not quite the same as the ordinary idea of a family. For instance, a married couple is normally regarded as a family, but if they share a house with another family and do not board separately, they do not appear as a private family in the census. It will be shown further on that this sort of discrepancy may give rise to rather serious underestimates of housing requirements.

Two other definitions, or rather a definition and a classification, have undergone important changes and deserve mention here. The first is the definition of a room. When a count of rooms was introduced in 1891 for the first time* no attempt was made to define a room. The returns thus included, or excluded, according to the views of the individuals completing the returns, bathrooms, w.c.'s, passages, lobbies, sculleries and kitchens as well as living rooms and bedrooms. A definition was not introduced until 1921. By it the only rooms counted were bedrooms, living rooms and kitchens.

The change of classification referred to concerns vacant houses. Until 1911 the censuses did not record vacant private dwellings separately owing to the absence of any definition of a private dwelling, and neither in 1911 nor in 1921 were vacants subdivided into furnished and unfurnished. As there is no alternative complete record of vacants, this lacuna in the census records has meant that there is no series of vacancy statistics from which deductions can be made about either what may be regarded as a normal supply of vacant houses, or variations in the supply.†

Comparability of Censuses

To-day inability to make accurate comparison of the total supply, composition of supply and of occupation of houses between the last three censuses and earlier ones is a matter of some inconvenience in historical research, but is not likely to hamper investigations of current problems unduly. Moreover, as far as historical research is concerned with broad trends, the difficulties created by the imperfect definitions and classifications of the earlier censuses are not very important. Reference to Table 1 in the section on "Housing Needs" below, will illustrate this. It was, however, a piece of great good fortune in connection with the assessment of inter-war housing

* The count of rooms was confined to dwellings with less than five rooms in 1891 and 1901, but extended to cover all dwellings with less than 10 rooms in 1911. Owing to lack of proper definitions of a separate dwelling, and of a room, the results of these early counts need to be used with much caution.

† A careful discussion of the vacancy statistics of the censuses is contained in the *Housing Volume* of the 1931 Census, chap. 3.

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problems that the 1911 Census contained enough improvements to make its data reasonably useful and capable of comparison with those of the 1921 and 1931 Censuses. Owing to the disturbances to the house market caused by the second world war, and the lack of a 1941 Census, this comparability is still important.

(b) *The Problem of Estimating the Number of Houses between Censuses*

It has already been stated that apart from the Population Censuses there are no complete records of the numbers of houses. The question of estimating the total number in existence for other than census years is of considerable importance. At first sight making such estimates would seem to be easy. Evidently in any intercensal year the number of houses must be equal to the result of a simple addition and subtraction sum. The number of houses must be equal to the total counted at the preceding census *plus* new houses built since then, *plus* the *net* addition to the number of houses due to the conversion of houses into two or more dwellings or other buildings into one or more dwellings, *minus* the number of dwellings demolished and *minus* the transfer of houses to non-residential purposes, e.g. offices. As is so often the case in statistical investigations, if only we could find the numbers the arithmetic would be easy.

Unfortunately we have adequate data only for the first two items, viz. the census figures and, since 1919, reasonably complete figures of new houses built.* The recent war not only deprived us of a 1941 Census, but also interrupted the six-monthly statement of new houses built, although the total number of houses built during the war years is available. Since the war there has been one improvement, however. The net increases in the numbers of dwellings by conversion of single houses into two or more dwellings are now published by the Ministry of Health with the statistics of new houses.†

The situation with regard to statistics of the various types of wastage is deplorable. Before the war the only figures of demolitions were those of houses closed or demolished under slum clearance schemes, and there was no information at all about houses transferred to non-residential uses. There is still no information under these heads. The war introduced two new sources of wastage—war damage and requisitioning of houses for non-residential purposes by the Government. There are no proper published figures of the latter, but it appears from approximate figures given in the *Ministry of Works Summary Report for 1945–46* that the number of requisitioned properties of all sorts had fallen from about 80,000 to 16,500 by December, 1946. Errors in estimates of the supply of houses on this score cannot therefore now be very large. Statistics of houses damaged or destroyed during the war are not published in any convenient place or in a complete way. They can, however, be obtained from the War Damage Commission classified as houses damaged or destroyed respectively, (*a*) ranking for "cost of works" payments, (*b*) ranking for "value" payments. The former cover the cost of rebuilding or repair, and are broadly intended for houses built since 1914; the latter are not intended to cover the cost of rebuilding or repair, but to compensate the owner for loss of value.‡

Even before the situation was complicated by the recent war the lack of statistical data on wastage and conversions was serious, for practically nothing is known about the rate of wastage of houses in this country, nor, except since the recent war, about conversions. Hence it is only possible to guess at the adequacy of the supply of new houses for inter-censal years. Some idea of the importance of the difficulty can be obtained from the following example. The increase in the number of houses in England and Wales between the Census of 1921 and that of 1931 was 1,420 thousand. The number of new houses built during this period was just about 1,620 thousand. Apparently then there was a net wastage§ of about 200 thousand houses, that is about 12 per cent. of the total supply of new houses in the whole 10-year period. We have no means of knowing during which part of the period this wastage occurred, or whether it was

* See below, Section II (*c*), on New Houses.

† Published in the *Housing Returns* and in the *Monthly Digest of Statistics*. See below, Section II (*c*). Figures for conversions by private builders are not available before April, 1946.

‡ Statements on "cost of works" and "value" payments are issued by the W.D.C. about once a year and appear in the Press.

§ Net wastage in this context means demolitions and transfers of houses to non-residential purposes *less* the increase in dwellings from conversions of buildings into dwellings and single houses into two or more dwellings.

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evenly distributed, nor is there any information about the relative importance of the various causes of net wastage. Thus we have no basis for making sensible estimates of the probable net wastage during the 1930's and, thus, no firm estimate of the number of houses in 1939. We know that about 260 thousand of the 2,330 thousand houses built in England and Wales between the 1931 Census and March, 1939, were offset by demolitions under slum clearance schemes. We cannot say, however, whether of the balance of 2,070 thousand new houses a quarter of a million, or two or three times as many, were balanced out by net wastage other than slum clearance. The possible magnitude of such an error is of importance in estimating present post-war requirements. Until we have a new census it is probable that nothing can be done to check up on this.

On the other hand, there seems little reason why statistics of wastage should not be published either annually, or for quinquennial periods. The actual information must be available in the records of the rating authorities. They necessarily have information about the numbers of houses ceasing to be assessable to rates owing to demolition, or changing the category for assessment owing to conversion to purposes other than private dwellings, or owing to conversions into two or more separate dwellings. It should not be impossible to arrange for the assembly and suitable tabulation of such valuable information. Incidentally information about vacant houses (provided they were unfurnished) should also be available from the same sources.

(c) *The Composition of the Supply of Houses*

Census Information

Statistical data of the composition of the whole supply of houses at any time are extremely scarce. The censuses since 1921 provide an adequate classification by numbers of rooms, but by definition exclude information about bathrooms, w.c.'s, etc., and no attempt has yet been made to include data on the availability of public utility services. It is to be hoped that favourable consideration will be given to including questions on these points in the future.

The Size of Rooms

Difficulties of collection of information of a more detailed kind are far more formidable. For instance, the size of bedrooms and living rooms is important in relation to the number of people using them, but it is evidently no light task to arrange for measurement of all the rooms in the country, or even for a reasonably large sample. There are indeed no statistics published showing the sizes of rooms, but much information was collected in connection with the Overcrowding Surveys carried out by the Ministry of Health for England and Wales and the Department of Health for Scotland in 1936. The report of the former includes a table from which it is possible to make some computation of the sizes of rooms in overcrowded houses.* Beyond this there are no statistics available.

The Quality of Houses

The assessment of the composition of the supply of houses in terms not merely of size, availability of services, etc., requires also data on the habitability of houses—whether they are free from damp, have adequate ventilation, light, etc. It is in practice extremely difficult to find a yardstick for such qualities, and *a fortiori* to define any minimum acceptable standard.

Officially there is a definition of houses "unfit for human habitation," but so far it has proved impracticable to formulate the phrase with sufficient precision to preclude varied subjective interpretations. There is little doubt that in the past it has been subject to widely different interpretations by the same local authority at different times and by different local authorities at the same time. This possibility of varying interpretations is particularly inconvenient, as the classifying of houses as "unfit for human habitation" should lead to action being taken by the local housing authority to see that the defects are remedied by the owners, or that the houses are included in some clearance scheme. Either may lead to litigation. The vigour with which it is convenient or seems good to pursue such policies has differed widely from time to time, and there is little doubt that this has influenced the interpretation of the term. Little reliance can be

* Ministry of Health *Survey of Overcrowding in England and Wales, 1936*, and Department of Health for Scotland *Housing Overcrowding Survey*, 1936, Cmd. 5171 and annual reports.

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placed therefore for example on the figures of houses included in slum clearance schemes as a guide of prevalence of "unfit" houses. Thus in January, 1934, the Local Authorities of England and Wales included 266,850 houses as "unfit" in their surveys intended to serve as a basis for a five-year slum clearance campaign. By March, 1937, this total had been raised to 377,930, and two years later it had mounted by about another 100,000.* If there had been no war, the total might well have increased further. However useful such data may be as an indication of what the local authorities intended to do, they cannot be used safely as a measure of the size of the "unfit" element in the supply of houses.

More recently a fresh attempt has been made to define a standard of fitness for old houses by a sub-committee of the Ministry of Health's Central Housing Advisory Committee.† It cannot be said that the sub-committee has been able to overcome the familiar difficulty entirely. In 1948 a contribution to the discussion of the problem was made by the Association of County Sanitary Officers. The Association's report‡ on the interim results of the survey of rural housing conditions, started by the Rural District Councils in 1944,§ contains a useful account of the problems of ensuring the application of a uniform standard in the survey. It also includes some discussion of different standards. Unfortunately it is clear that widely varying standards have been used in the survey, and that the statistics published in the report should be used with great care.

Information of a rather different type could, it may be suggested, be obtained from data on the rateable values of houses.‖ The rateable values are intended to reflect the net annual value of a house, and thus to provide an indication of the wealth of the occupant as a basis of assessment for local rates. Theoretically they should therefore provide a comparative measure of the quality of dwellings. Unfortunately there are serious difficulties about using them, apart from the practical difficulty of assembling and tabulating the detailed records of all houses of the numerous rating authorities. The most important difficulty is the lack of uniformity in methods of assessment, which has been aggravated by the problems created by rent restriction.¶ If this fundamental difficulty could be overcome, it should not be beyond the wit of statisticians to find some means of allowing for the proper differences between houses in the same town and between large and small towns, and towns and country due to differences in site values. Until reasonable uniformity of methods of assessment is achieved, however, any rateable value statistics need most careful handling.

(d) *New Houses*

1919–39

The statistics of new houses built originated with the introduction of the policy of housing subsidies after the first world war. With the imposition in 1919 on Local Authorities of the duty of providing working-class houses and the provision of Treasury subsidies to them for the

* *Slum Clearance Programmes of Local Authorities in England and Wales*, 1934, Cmd. 4535, and Ministry of Health *Annual Reports*.

† *Report of the Standards of Fitness for Habitation Sub-Committee of the Central Housing Advisory Committee*, 1946.

‡ Association of County Sanitary Officers. *Interim Report of the Housing Survey in Rural Areas in England and Wales*, 1948.

§ The survey was started on instructions of the Ministry of Health.

‖ The Interdepartmental Committees on the Rent Restriction Acts of 1931 and 1937 (*Reports*, Cmd. 3911 and 5621 respectively) gave estimates of the number of houses in the following rateable value classes: England and Wales, £13 or under; £13–£35; over £35. Metropolitan Police District, £20 or under; £20–£45; over £45; Scotland, £26 5*s*. or under; £26 5*s*.–£45; and over £45.

The earlier estimates for 1919 appear from other information to be rather too low. Some discussion of the estimates and further calculations based on them are given in my book, *Housing and the State, 1919–44*, Allen & Unwin, 1945: Statistical Appendix, Tables 3*a*, 3*b* and 3*c* and attached notes.

Statistics of the annual values of houses assessed for the Inhabited House Duty were available up to the beginning of the first world war in the *Reports of the Commissioners of Inland Revenue*. Although they were not substitutes for statistics of rateable values, they were of some interest.

¶ For a detailed study of the vagaries of assessment practice, see *Report of the Ministry of Health Departmental Committee on Valuation for Rates, 1939*, published 1945, and Occasional Papers, Nos. VII and VIII, of the National Institute of Economic and Social Research, *The Problem of Valuation for Rating* by J. R. and U. K. Hicks and C. E. V. Lesser, 1944, and *The Incidence of Local Rates in Great Britain*, by J. R. and U. K. Hicks, 1945.

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purpose, returns were naturally made of the numbers of houses built ranking for subsidy. Subsidies also given to private enterprise led to similar returns. Since October, 1922, the records of new houses have been extended to cover houses built without subsidy, either by local authorities or by private enterprise, with rateable values up to £78 in England and Wales (£105 in the Metropolitan Police District). The statistics for England and Wales were published in the *Ministry of Health's Annual Reports* and, in addition, since September, 1934, until the outbreak of the second world war, in a six-monthly statement (called "Housing") of the progress made with house-building, slum clearance and "de-crowding."* The statistics for Scotland were published only in the *Annual Reports of the Department of Health for Scotland.*

The classification of the new houses according to the conditions under which they were built is important, as it provides some information about the supply of houses for different sections of the population. The Treasury subsidies for Local Authority houses were available for varying periods for the general needs of the working classes under the Housing and Town Planning Act, 1919, the Housing, etc., Act, 1923, and the Housing (Financial Provisions) Act, 1924. Special subsidies for slum clearance and the abatement of overcrowding, or more colloquially, de-crowding, became available under the Housing Acts of 1930 and 1935 respectively, thus providing groups of new houses built for special sections of the population. The local authorities also had powers to build houses without Treasury subsidy under the Housing Acts of 1925, 1936 and 1938.† The classification of houses under the Acts thus provides *inter alia* a basis for study of additions to the supply of working-class houses built under various terms and thus theoretically available at different average rents. The pooling of subsidies in the Local Authority housing accounts under the Housing Act of 1936 naturally detracted from this aspect of the statistical interest of the classification.

The classification of the houses built by private enterprise (including public utility societies) is important for similar reasons. No information for England and Wales is available about these houses except that yielded by the fact that they must have conformed to the conditions laid down for eligibility for the various subsidies. Houses built by unsubsidized private enterprise in England and Wales were divided in the returns into two classes—those with rateable values up to £26 and those with rateable values over £26 and up to £78 (£35 and £35–£105, respectively, in the Metropolitan Police District). The group with the lowest rateable values included all working-class houses and those of the lower and medium middle class; the higher class covers approximately the houses of the better-off professional and upper middle classes, and, indeed, all the rest of the houses except those few built for the really rich. In September, 1934, with the first appearance of *Housing*, these rateable value divisions were further subdivided, the lower one at the compounding limit, i.e. up to £13 (£20 in the Metropolitan Police District), which covers traditionally the bulk of working-class houses; the upper division was divided at £52 (£70 in the Metropolitan Police District). At the same time the houses in the two lowest rateable value classes were divided into those built for letting and those built for owner-occupation, thus providing for the first time some indication of the contribution of unsubsidized private enterprise to the supply of working-class houses to let.

The statistics of new houses were rather different in Scotland from those in England and Wales and were more detailed. Houses with more than five apartments built by unsubsidized private enterprise were recorded only in a note to the main table. The houses built by Local Authorities and subsidized private enterprise, however, were each classified both according to the Act under which they were built and according to the number of rooms, while houses built by private enterprise without subsidy with five rooms or less were also classified according to the number of rooms. No information about rateable values was published. The explanation of these differences is that in Scotland overcrowding is extremely serious owing to the prevalence of two- and three-roomed houses. The success of the inter-war housing programmes thus turned in part on the provision of four- and five-roomed houses. Hence the interest in the question of the size of houses built and, as a by-product, the more detailed statistics. Houses with five or more rooms

* The last table in *Housing* gave a most useful statement of the numbers of houses built by Local Authorities and private enterprise, respectively, in individual Local Authority areas. Earlier figures of this type are not published, but were in existence in the Ministry of Health at any rate in 1944.

† A slum clearance subsidy was available under the 1925 Act, but little use was made of it.

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accounted for only about an eighth of the total number of houses built by unsubsidized private enterprise.

To sum up: adequate statistics are available of the numbers of houses built in the inter-war years. For information about the composition of the supply in England and Wales we are dependent for subsidized houses on the classification according to the Acts under which they were built. For unsubsidized private-enterprise houses the information is solely in terms of rateable values, for which reasonably fine divisions were introduced only in 1934; the classifications into rateable value categories is subject to the uncertainties already described. It is not at all easy, as I found a few years ago, to build up an accurate statistical picture of the composition of the supply of new houses in England and Wales from these data.* The detail of the Scottish statistics is considerably greater, and it is possible to provide a much better analysis of composition of supply.

1940–50

Since the end of the second world war the Ministry of Health has transformed its modest six-monthly report *Housing* into a more imposing and elaborate document called *Housing Return for England and Wales*. This is published in two parts, and occupies together over 100 pages compared to the mere 18 pages of the pre-war report. From January, 1946, to May, 1946, it was published monthly but is now published only quarterly; a separate summary statement of the numbers of houses built is published monthly. Since the war the Department of Health for Scotland has also published a special housing report of a similar though less elaborate type, and the detail of Scottish house-building progress is now, for the first time, fairly easily comparable with that of England and Wales. The expansion of the Housing Return is due primarily to developments in the scope and detail of the statistics, reflecting the acute public interest in the whole subject.

The word house, even amplified by flats, is no longer adequate to describe dwellings. The Ministry of Health now works in terms of "units of family accommodation provided," a utilitarian, but singularly un-homelike description of the erections people live in. There are many species of this genus ranging from ordinary houses and flats built in the traditional manner, through those built by new methods but classed as permanent, to the numerous varieties of temporary houses and mere hutments. These species are treated in varying statistical detail, and for the most important there are tables showing the number of houses at each stage from submission of plans to completion.†

A great improvement in the Return for England and Wales on pre-war practice is the introduction of regional break-downs of the more interesting tables and a classification into *Urban Areas* divided into three groups, large towns and cities, medium, small, the *L.C.C. and Metropolitan Boroughs* (which for some reason are not regarded as falling into the class Urban Areas), and Rural Authorities. These are really useful innovations and it is to be hoped they will be retained. The introduction of statistics of conversions of houses into two or more dwellings is also a welcome improvement. The second part of the Ministry of Health return and the last half of that for Scotland are devoted to more detailed statistics than were provided before the war for each local housing authority.

The most obvious omissions of information that was given before the war are those previously provided by the classifications of houses built by unsubsidized private enterprise in England and Wales by rateable values, and in Scotland by numbers of rooms of all new houses with less than five rooms. It is to be hoped that these classifications will be revived, and that the classification by rooms (with a higher limit) will be extended to England and Wales. It would be quite sufficient if the detailed data were published once a year.

III. Housing Needs

The Numbers of Houses Required

The main importance of the statistics of houses is to enable us to compare the houses available with the houses required. It is to the problem of estimating housing requirements, therefore,

* See *Housing and the State, 1919–44*, op. cit. Statistical Appendix Tables 3*a*, 3*b*, 3*c*.
† Summaries for Great Britain are published in the *Monthly Digest of Statistics*.

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that this section is devoted. The number of private families recorded in the census does not, of course, provide accurate information about the number of families which may require separate houses, for the census definition of private families makes the number of private families partly dependent on the number of houses. For the same reason it is impossible to use the data for forecasting future requirements.

The Registrar-General made an important attempt (published in the *Housing Volume* of the 1931 Census) to estimate the number of private families in a way more useful for housing problems. He tried three assumptions: *A*, that the number of private families was identical with the number of married women; *B*, that widows and widowers under 65 years of age should be included; *C*, that an addition should be made for some single persons who might require their own establishment, and for this purpose he added 10 per cent. of the persons of both sexes between 20 and 45 years of age. The results of these calculations are shown in the table below. It will be appreciated that no allowance has been made for families within these categories who wish to share houses as lodgers, etc.

TABLE 1.—*Private Families in England and Wales and Inter-Censal Increases*, 1861–1931, *from the Housing Volume of the* 1931 *Population Census*

	Dwellings	*Separate occupiers*	*Census private families*	*Registrar-General's estimates of private families*		
				A	*B*	*C*
	Inter-Censal Increases Percentage					
1861–71	15·2*	12·4	..	13·2	13·3	13·2
1871–81	15·4*	11·6	..	12·4	12·5	12·9
1881–91	11·6*	8·8	..	10·8	10·6	11·3
1891–1901	15·2*	14·8	..	16·3	15·3	16·0
1901–11	12·5*	13·8	..	16·0	13·9	14·3
1911–21	3·7	..	10·0	14·5	14·6	13·7
1921–31	17·8	..	17·1	13·4	11·8	12·1
1911–31	..	..	28·8	29·8	28·2	27·5
	Numbers at census dates ('000)					
1861	..	4,492	..	3,489	4,172	4,219
1871	..	5,049	..	3,949	4,727	4,776
1881	..	5,633	..	4,438	5,319	5,391
1891	..	6,131	..	4,917	5,883	5,999
1901	..	7,037	..	5,718	6,783	6,959
1911	..	8,005	7,943	6,630	7,729	7,953
1921	..	..	8,739	7,590	8,861	9,046
1931	..	..	10,233	8,604	9,909	10,140

* All dwellings including those occupied by non-private families. Blocks of flats, etc., counted as one dwelling.

It will be noticed that the differences in requirements resulting from the estimates *A*, *B* and *C* are smaller for the intercensal increases required than for the total numbers required at a particular census date. Comparison of the three estimates with the figures of separate occupiers and "census private families" is interesting. For instance, the numbers of private families according to estimate *C* are about 5 per cent. less than the numbers of separate occupiers for the three census years 1861 to 1881, about 2 per cent. less for 1891, and just over and just under 1 per cent. less for 1901 and 1911 respectively. The differences between the numbers of census private families and the *C* estimates for 1911 and 1931 are so small as to be negligible—less than 1 per cent. But the correspondence is much less good for 1921, when instead of the census families exceeding the *C* estimate of families as in all the other years, the position was reversed.

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This break in the approximate agreement between the results of the different methods of defining families appears to justify abandoning the use of census definition of private families whenever possible in making estimates of housing requirements. It is significant that the breach came at the census following the intercensal period in which the increase in the number of private houses had been unusually small, 3·7 per cent., owing to the first world war. The factors affecting the numbers of people who might be supposed to wish to set up in houses on their own had not been affected in the same way, taking the ten-year period as a whole. The effect of the divergence between the estimates of private families on estimates of housing requirements was important. According to assumption *C* the increase in private families between 1911 and 1921 was 1,093 thousand, that is, 40 per cent. greater than the increase in the number of census private families!

The Composition of Requirements

The problem of estimating the character of houses required to provide a reasonable fit between the size and composition of families and the houses they occupy is far more difficult. There is much less information published about the detailed composition of families than about the age and sex composition of the population. The *Report on the Survey of Overcrowding of 1936*, already referred to, provided a comprehensive picture of the correspondence between the size of working-class houses and the size and sex composition of the families living in them. The analysis of the survey was based on the standard of the permitted numbers of persons per room laid down in the Housing Act of 1935, and thus provided a guide to the deficiencies in supplies of houses at that time. Not only is that survey now out of date, but it did not give any information about private families, in the ordinary sense, living in multiple occupation of houses. Such detailed information that comes to light about this from time to time shows that there are in fact numerous unexpected types of groups of people living together. While common sense suggests that some of them prefer to live in this way, until more is known about them it is difficult to estimate their effect on the composition of the supply of housing requirements. In fact, the census records could provide a great deal of the information required if it were analysed and tabulated in more detail. It might be suggested that at the next census this should be done for an appropriate sample of the whole population.*

The problem of estimating housing needs on a basis of quality of houses is simply the problem of discovering how many houses are substandard, or unfit for human habitation, on whatever standard is selected, and, therefore, require replacement. The difficulties of defining such criteria have already been described and the consequent lack of data for forming an estimate.

The complication of the elements—numbers of houses, sizes of houses and quality of houses, vacant houses—that need to be taken into account in preparing estimates of housing requirements leads to great confusion. In particular it is necessary to find out in considering any estimate just how far these four factors have been taken into account, as well as the basis on which the estimate has been calculated.†

IV. FINANCE AND RENTS

Central and Local Government Housing Finance

The statistics of expenditure by the government and Local Authorities on housing provide no particular difficulties and are reasonably accessible. The government's expenditure consists mainly of subsidies to Local Authorities, and is included, of course, in the *Annual Financial Accounts of the United Kingdom*. Information as to Local Authority receipts and expenditure on capital and income account for housing is included in the detailed accounts of the Local Authorities

* The *Housing Volume* of the 1931 Census (chaps. 6–9) included a special analysis of the composition of census families in certain selected areas. This is an illuminating inquiry, and would be undoubtedly of great value if extended to the whole country.

† For a striking illustration of the wide variations in estimates of requirements see the Oxford Institute of Statistics Bulletin Vol. 7, No. 13, Sept., 1945, *Estimates of Housing Needs*, by S. Moos, and for an important correction of a mis-quotation of estimates in the above article, Vol. 7, No. 16.

An official estimate of post-war housing requirements for Scotland is contained in the report of the Department of Health for Scotland: *Distribution of New Houses in Scotland*, 1944, Cmd. 6552.

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published in the *Local Government Financial Statements.** Some analysis of their capital expenditure was included in *Public Investment and the Trade Cycle* by Bretherton, Burchardt and Rutherford,† and a rather different type of analysis (for the County Boroughs only) in my book *Housing and the State, 1919–44*. The income accounts of the Local Authorities show under separate heads receipts from rents and from central government subsidies, and also the outgoings on loan charges separately from other expenses as well as the deficit or surplus to be carried on the rates.

Finance of House Purchase

For unsubsidized privately-built houses there are no statistical data either on income or capital expenditure, except those relating to finance of house purchase through building societies or under the Small Dwellings Acquisition Acts. The accounts of the building societies are summarized and published in the *Annual Reports* of the Chief Registrar of Friendly Societies (published in summary form only since the outbreak of war). There is much interesting information in these reports about the size and finance of the building societies, and various useful details about the size and number of advances made on mortgage. Unfortunately, however, it is impossible to discover from the tables either the number of houses being purchased at any time, or annual changes in the number, or what proportion of the advances are for the purchase of new houses. The statistics of activity under the Small Dwellings Acquisition Acts, published in the *Ministry of Health Annual Reports*,‡ are of some intrinsic interest, but do not provide a substantial contribution to the statistical data on house purchase, as the use made of the Acts is extremely limited. For instance, the total advanced under the Acts from January, 1919, to March, 1939, in England and Wales was only £105 million, compared to £137 million advanced by the building societies on new mortgages in the one year, 1937.

Rents

Statistics of rents are necessarily very difficult to deal with owing to the fact that houses are not standard articles. Collections of rent statistics are, indeed, most frequently made with the purpose of finding out how much is spent by particular sections of the population on rent or house purchase. One of the earliest important investigations was made by the Board of Trade in 1912 as part of its inquiry into the cost of living.§ The more comprehensive surveys of life and labour in particular towns|| frequently include some data on rents actually paid. The most recent comprehensive survey is, of course, that included in the Ministry of Labour Inquiry into the Cost of Living in 1937–38. This also includes information on the proportion of the sample buying, or owning, their own houses and the amounts paid out per week for the purpose.¶ The inquiries so far mentioned are all concerned with the working classes, but a middle-class sample was investigated by Mr. P. Massey in 1938–39 and the results published in the Royal Statistical Society's *Journal* in 1942.**

These inquiries, though of much interest from other points of view, do not provide genuinely comparable statistics of the price of accommodation, for they do not refer to a standard article. The early Board of Trade inquiry does, however, give rents separately for dwellings of different sizes, and this sort of differentiation is occasionally found in private inquiries.

Statistics relating specifically to rents of Local Authority houses were collected by the Ministry of Health and the Department of Health for Scotland and published in 1937 and 1938 respec-

* Up to 1934 called the Annual Local Taxation Returns. The series was interrupted by the recent war and only a brief summary is now published.

† Clarendon Press, 1941.

‡ And before the war in *Housing*, op. cit. The information for Scotland is published in the *Annual Reports of the Department of Health for Scotland*. The statistics give the number of houses on which advances have been made in England and Wales but not in Scotland, as well as the amount advanced. Details of advances for individual Local Authorities are included in the *Local Government Financial Statements*, op. cit., but see Note above, p. 406.

§ *Board of Trade Cost of Living Inquiry, 1912*. Cd. 6955.

|| e.g. *New Survey of London Life and Labour*, 1930–35; *Human Needs of Labour*, 1937, and *Poverty and Progress*, 1941, by B. Seebohm Rowntree.

¶ The results were published in the *Ministry of Labour Gazette* in December, 1940, and January, 1941.

** *The Expenditure of 1,360 British Middle Class Households, 1938–39.*

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tively.* These collections showed for each of the larger Local Authorities, and for the smaller ones grouped in counties, the numbers of the Local Authority houses let at various subsidized rents. Unfortunately no classification was made of the size of the houses let at various rents, and owing to the freedom with which Local Authorities can allocate the housing subsidies, it is impossible to attach particular rents to particular sizes of houses. Thus, although there is probably rather less range of variation in the type of house included than in the other collections referred to, it is impossible even in this case to use the statistics as indicating the prices of a standard type of house in different areas.

V. House-Building Costs

Wage Rates and Price of Materials

The usual information is available about building wage rates and building material prices for the building industry as a whole. Both wages and material prices are, however, subject to considerable local variation. As building wage rates normally move together in all localities the local variations in actual rates is not important for many purposes, but changes in the classification of localities for the purpose of wage agreements have to be watched. The prices of all materials cannot be relied upon to change in the same way in different areas, however, chiefly owing to the importance of transport costs in the delivered prices for the important bulky materials, such as bricks, cement, etc.

Index Numbers

The only continuous series of building costs available for the inter-war years† is the Index Number constructed by the *Economist* for the period 1924 to the outbreak of the recent war; it has not been published since. The index includes wage rates (London and Manchester) and the prices of eight materials (London quotations).‡ Wages and prices were given equal weights in the index, which was constructed with reference to the building industry as a whole. Neither this weighting between wages and materials as a whole, nor that for individual materials, are strictly correct for housing. Indeed the equality of weighting between labour and materials would be regarded as inappropriate by house builders, who commonly quote wage costs as about one-third of combined labour and material costs.

An index number of this type can, of course, only be regarded as a reasonable measure of changes in building costs, apart from the problem of the initial choice of weights, if two conditions are satisfied: first, that the productivity of labour remains unchanged, for otherwise the changes in wage rates included in the index will only by accident reflect changes in the labour costs of building correctly; second, that overhead costs including profits have moved in the same way as the index number of wages and material prices. It seems probable that these conditions were reasonably well fulfilled during the period for which the *Economist's* index number was calculated.§ In view of the disturbances and changes in the building industry brought about by the war, it is practically certain that these conditions have not been satisfied since 1939, and

* *Rents of Houses and Flats owned by Local Authorities in England and Wales, 1937*, Cmd. 5527; Appendix 8 of the *Annual Report of the Department of Health for Scotland, 1938*.

† A variety of index numbers of selling prices of various types of building work and of building material prices and wages was calculated for the period 1845–1922 by the late G. T. Jones. The index numbers together with a careful discussion of the problems involved in measuring costs were published in 1933 in his book *Increasing Returns* (Cambridge University Press).

‡ The wage rates used in the index are those for bricklayers, masons, carpenters, joiners, plasterers, painters, slaters, plumbers and labourers. The materials included are bricks, stone, wood, tiles, joists and girders, lead, paint and glass. For further details see the *Economist*, 1933 volume.

§ For an interesting attempt to measure divergences between changes in building costs and changes in the general levels of wages and prices, and to identify changes in overheads and profits, see L. R. Connor, "Urban Housing in England and Wales," a paper read to the Royal Statistical Society in November, 1935, and published in the *J.R.S.S.*, 1936.

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construction of any index of building or of house-building costs requires more information about productivity and overheads, including profits, than is at present available.*

The Board of Trade has published since 1930 an index number of the wholesale prices of building materials, including nine broad categories of materials. In this index number, as in that of the *Economist*, the weights for individual materials were selected for the building industry as a whole and not specifically for house-building. It is probable that the appropriateness of the weights even for the building industry as a whole is to-day open to question, as a result of changes in relative importance of different types of building work and the use of substitutes for timber. It is understood that the possibility of re-constructing the index number is under discussion.†

Professor Bowen constructed a new index number of building material prices in 1946. His index covers more materials than that of the Board of Trade, and the weights are chosen to indicate the relative importance to the whole building industry since 1939 of the materials included. He distinguishes between this relative importance between 1939 to 1945 and 1945 to date, naming the index weighted for the earlier period "Wartime Index" and that of the later period "Peacetime Index." The peacetime index (including 33 materials) started in the third quarter of 1945 (1939 = 100), and in the last two quarters of that year was above the Board of Trade Index by 9 and 11 points respectively. In more recent years the two index numbers have, however, been very close together.‡

The possibility of measuring changes in house-building costs by a specially weighted index number instead of by relying on general index numbers has been frequently discussed, but so far no new index number is available for this purpose. Such an index number would, of course, suffer from the defects already described, but the probability of the weights becoming incorrect would be rather less serious.

Other Methods of Measuring Costs

The difficulties of constructing index numbers of building costs are particularly unfortunate owing to the absence of any standard house of which the final price (or costs if available) could be regarded as an indication of changes in house-building costs. Theoretically it might be thought possible to select a particular type of house, and to record the cost of building it (or its final price) at successive dates. To the extent that the costs, or price, of such a house were typical of all houses, a valid measurement of changes in house-building costs in general would then be available. Unfortunately serious difficulties must arise in any such attempt. The cost of building a house varies not only with the detailed specifications of the house, but also with the locality and type of house, and, also, with the numbers of houses being built in the same building scheme. It is possible also that there are considerable variations in the costs of different builders. Even if standard houses were built and a sufficiently large sample could be obtained, only some of these difficulties could be overcome. It is most improbable that the composition of the sample could be maintained sufficiently constant over a useful period, for the character of building activity is essentially local. Hence, continuous demands for houses with similar specifications to be built

* Careful attempts to measure differences in building costs of building houses by various new methods of construction and traditional methods have been carried out since the war by the Ministry of Works. The results so far available were published in *National Building Studies, Special Report No. 4: New Methods of Construction*, and an account of the statistical methods employed was given by Dr. J. Bronowski and others in a paper read to the Royal Statistical Society on April 27th, 1949, published in the Society's *Journal*, Vol. CXII, Part III.

† The weights of the Board of Trade Index Number have not been changed, but considerable alterations have been made in the exact specifications for the individual materials for which prices are included. A careful study of the price changes for the original specifications included would be necessary in order to assess the exact effect on the comparability of the index number over the whole period before and since 1939.

‡ The weights of the "peacetime index" are based on "the proportion which the total gross value of the output of each individual item bears to the value of the output of all the materials included in the index" in 1945. See Professor Bowen's article "Rises in building material prices" in the *Oxford Institute of Statistics Bulletin*, Vol. 8, No. 11, Nov., 1946, for a full description of the construction of this index and also for the "wartime index." The "peacetime index" is published in the *Architects' Journal*. There are also some useful commentaries on current official building statistics by him in a series of articles in the same Journal in 1945–46.

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under reasonably similar conditions are unlikely in the same locality (except sometimes where large Local Authority housing schemes are carried out), and the builders and areas included would be constantly changing.

The series approaching most nearly to this method of measuring building costs is that of average contract prices accepted for local authority three-bedroom, non-parlour houses, published by the Ministry of Health in the inter-war period.* Although the series covered all Local Authorities in England and Wales who were placing contracts, it seems possible that the changing relative importance of the contracts of different authorities may have slightly affected the consistency of the series, for there were considerable differences in contract prices between Local Authorities. Much more certainly important, however, were changes in subsidy policy and Ministry of Health advice about the size and quality of Local Authority houses. For instance, in the early and middle thirties Local Authorities were pressed, following changes in subsidies, to provide houses as cheaply as possible by simplifying standards and concentrating on three-bedroom houses of 750 ft.sp. instead of over 800 ft.sp. Towards the end of the thirties there was some reaction from these lowered standards, and many local authorities increased the size of the houses they built. Changes in the series of average contract prices are thus the product of both changes in standards and changes in building costs, and do not provide a true measurement of changes in the latter.

The series of Local Authority contract prices, the *Economist's* Index Number of Building Costs and the Board of Trade Index Number of Wholesale Prices of Building Materials, together with series for building wages, are shown in Table 2 below.

TABLE 2.—*Index Numbers of Building Costs, Building Wage Rates and Material Prices*, 1924–38 (1930 = 100)

	Building costs		*Wholesale prices of building materials, Board of Trade index*§	*Weekly wage rates*‖	
Year	*Local Authority average contract prices**	Economist's *index*		*Bricklayers*	*Builders' labourers*
1924	125·8†	109·6	..	104	105½
1925	129·3‡	106·4	..	104	105½
1926	129·3	106·8	..	104	105½
1927	120·5	105·0	..	104	105½
1928	106·2	103·1	..	102	103½
1929	101·5	100·0	..	102	103
1930	100·0	100·0	100·0	100	100
1931	97·9	96·4	96·4	97½	98
1932	89·6	94·2	94·5	95	95
1933	85·5	91·0	92·5	92½	93
1934	85·3	90·7	92·6	92½	93
1935	88·0	97·2	93·8	93½	93
1936	92·1	100·9	96·7	97	98
1937	104·6	107·2	104·2	99½	100
1938	107·9	107·2	104·1	102	103½

* Annual averages of quarterly average price of contracts let for ordinary three-bedroom non-parlour houses, excluding the cost of land.
† Average of the monthly averages for March, June, September and December.
‡ Average prices for March included instead of those for the 1st quarter, which are not available.
§ Not available before 1930.
‖ Ref. A. L. Bowley's Index Numbers. Annual averages except for 1924, for which December rates have been used.

It will be noticed that the series of contract prices shows a much greater range of fluctuations than the *Economist's* Index, and that this in turn varies slightly more than the Board of Trade

* See *Annual Reports of the Ministry of Health.*

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Index of Building Material Prices and the series of weekly wage rates in the building industry. The differences between the last four series are not important, but those between the series of contract prices and the *Economist's* Index are. It is, however, impossible to tell how many of the discrepancies are due to the unsuitability of the weighting of the *Economist's* Index and how much to changes in the article produced—the houses.

The effects on the costs of building Local Authority houses of changes in the productivity of labour, and in the type of house built, have been analysed to some extent for the years 1939 and 1947 in the Reports of the Ministry of Health and Department of Health for Scotland Committees on house-building costs, published in 1948.* The Report of the Working Party on Building, published in May, 1950, contains a summary analysis of trends in costs up to 1949.†

VI. The Structure of the House-Building Industry

Pre-war

Pre-war data on the structure of the building industry are confined to those contained in the Censuses of Production. As the output of the industry is not classified according to the type of product, e.g. houses, industrial buildings, etc., the censuses provide no separate information about the structure of that part of the industry which builds houses. The only information available for the inter-war period about the division of the output or resources of the industry between houses and other building work was that given by the monthly returns of the value of building plans passed for a sample of large urban Local Authorities. These figures were published in the *Ministry of Labour Gazette*. Even apart from the possible effects of the omission of many local authority areas, including the L.C.C., these statistics cannot be regarded as a wholly reliable guide, as buildings for which plans were passed may not all have been built. Changes in trade prospects may have affected differently the extent to which plans for various types of buildings were carried out.‡

Post-war

Post-war statistics are much more complete for the industry as a whole, and also better with respect to house building. As a war measure the Ministry of Works set up a compulsory register of building and contracting firms, and required returns of the type of work done and the numbers of men employed on it. This has been continued since the end of the war. Quarterly statistics are now published in the Ministry of Works *Summary Annual Reports* showing the number of males employed on different types of housing work and also for the main classes of other work.§ Less detailed monthly figures appear in the *Monthly Digest of Statistics*, and more detailed figures in the *Housing Returns* for England and Wales. Six-monthly analyses of the firms of various sizes, classified according to the numbers of persons employed, are also included in the Ministry of Works *Summary Annual Reports*, but unfortunately there is no cross-classification of firms by type of work done. The statistics of licences issued by the Ministry of Works for various classes of building work, and the number of houses for which building licences have been issued to private builders by the Local Authorities,‖ to some extent replace the old statistics of the values

* The English report is called *The Cost of Housebuilding* and the Scottish one *Scottish Building Costs.*

† See particularly Appendices E and F.

‡ These statistics were interrupted for a time after the third quarter of 1920, as it was considered that a substantial, but unknown, proportion of the buildings for which plans had been passed were not erected owing to the break in the trade boom in that year.

Comparability of the values of plans passed as an indication of building activity from year to year is of course affected by changes in the costs of buildings, but I am not aware of any evidence that such changes affected the value of plans for houses differently to the values of plans for other types of buildings, and thus the comparability of the composition of the values.

§ An analysis of the value of output of the building and contracting industries each quarter from June, 1945, to December, 1946, was included in the Ministry of Works *Summary Report, 1945–46*, but not the analysis by number of males employed. The latter is included, however, in the *Monthly Digest of Statistics*, and also in the *Housing Returns*. These early post-war figures are somewhat less reliable than the later ones.

‖ Published in the Ministry of Works *Summary Annual Reports* and the *Housing Returns* respectively and also in the *Monthly Digest of Statistics*.

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of plans passed. Owing, however, to the changes in the value of work for which licences are required and in the allocation of the duty of issuing licences between the Ministry of Works and the Local Authorities, these statistics should be used with the utmost care.*

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* For an analysis of the structure of the industry during wartime see *Statistical Tables Relating to the Building and Civil Engineering Industry in Wartime*, published by the Ministry of Works. For a discussion of these tables, which have little bearing on house building owing to lack of house building during the war, see S. Moos, *Employment and Output in the Building Trades, Oxford Institute of Statistics Bulletin*, Vol. 8, No. 2, Feb., 1946.

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REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

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1.—*Introduction to the Theory of Probability and Statistics.* By N. Arley and K. R. Buch. New York: John Wiley (London: Chapman and Hall), 1950. xi + 236 pp. 9″. 32*s.*

This is an introduction to the theory of statistics which was originally published in Danish and has now been translated. The authors are a physicist, well known for his contributions to the theory of stochastic processes, and a pure mathematician. The first three of the twelve chapters deal with the theorems of the calculus of probability and outline in an elementary way the differences of opinion which exist on this subject. The authors make an important point, which is often ignored, in a footnote on p. 10, when they write, "We stress that it is our positive knowledge, i.e. of the physical properties of a die, which leads us to expect each result as equally probable. Nevertheless it is sometimes stated that this expectation is due to out ignorance of the behaviour, i.e. of a die." Chapter 4 is devoted to random variables and their distributions and is remarkable in that, although mean values and dispersion are not reached until the next chapter, it contains (in small print) a six-page discussion of stochastic processes, including the Fokker-Planck equation and applications to statistical mechanics. Chapters 5 and 6 discuss the mean values and dispersions of random variables and functions of random variables. Theorems on characteristic functions are stated but not proved. Chapter 7 is concerned with the normal distribution and contains proofs of the χ^2, t and F distributions. Chapter 8 deals with Tchebycheff's inequality, laws of large numbers, and the central limit theorem, a proof of the latter being given in the case where all the variates have the same distribution and a finite third absolute moment. Chapters 9 and 10 consider the relationship between probability and statistics with particular reference to the fitting of distributions and methods of estimation. The χ^2 goodness of fit test is not considered but there are short discussions of maximum likelihood and the method of fitting by moments. It is a pity that no mention is made here, or elsewhere, of the idea of errors of the first and second kind.

Chapter 11 deals with the theory of errors and includes a short discussion of correlation in two variables only. Chapter 12 is unusual in an English book on statistics in dealing with the use of least square in problems of "adjustment," or what the Germans call Ausgleichungstheorie. These are chiefly problems of surveying. The book concludes with an interesting set of problems and a list of references.

The mode of approach to statistical problems largely reflects the authors' interest in physical science and for a person of such interests this book provides a clear, accurate, and useful introduction. The biologically minded mathematician would, however, require to supplement it by other reading, for example, on the design of experiments, which is not considered although increasing use of it is being made by physicists and chemists. The translation is good and the mathematical treatment clear and accurate. One interesting feature is that French and German translations of the principal technical terms used in statistics, are given when the latter are defined. Nowadays, when every type of scientist feels the need of further knowledge of probability and statistics, the present book can be well recommended as an introduction and even the expert will find a few things in it which he did not know before.

P. A. M.

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2.—*The Extrapolation, Interpolation and Smoothing of Stationary Time Series, with Engineering Applications.* By Norbert Wiener. New York: John Wiley (London: Chapman & Hall), 1949. ix + 163 pp. 9″. 32*s*.

This is a reissue, in book form, of a secret report originally widely circulated in 1942. It was commissioned by the U.S. National Defence Research Committee with a view to developing the mathematical theory of stochastic processes necessary in the design of predictors for artillery. The result is a book of very great interest which approaches the problem of stationary stochastic processes in a manner somewhat unfamiliar to most statisticians.

The origin of the theory is to be found in a famous paper by Wiener in Vol. 55 of *Acta Mathematica* (1930). It is well known that a function, the square of whose modulus is Lebesque integrable, can be represented as a Fourier integral and that this representation may be regarded as a harmonic analysis of the function. In his *Acta Mathematica* paper, Wiener set himself the problem of extending this theory to the class of functions $f(t)$ which are L^2 integrable over every finite interval and for which

$$\lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |f(t)|^2 dt = A < \infty.$$

The importance of this type of generalization is that it enables us to discuss the harmonic analysis of such a function as $\sin t$ which is not $L^2(-\infty, \infty)$. If the above condition holds, we can define what Wiener calls a serial correlation function of $f(t)$ which is really more akin to what a statistician would call a serial covariance. This serial correlation function can itself be represented as the Fourier Stieltjes transform of the integrated power spectrum of $f(t)$. So far the idea of probability has not been introduced but the analogy with the theory of continuous stationary stochastic processes developed by Khintchine (and not mentioned in this book) is clear. The next thing to do is to relate this theory, which Wiener had already developed with great success, to the theory of stochastic processes. This he does by applying the theory to each actually realized time series $f(t)$ out of a class of such series and setting up a probability measure in this class by tagging each realized series with a variate α which can be supposed to have a rectangular distribution (say) on the interval (0, 1). This is equivalent to an equimeasurable mapping of a function space with a measure on to an interval. The individual series, which we now call $f(t, \alpha)$, is then a sample of one out of a population or "ensemble" of such functions. Then by using a form of the ergodic theorem to identify space averages and probability averages, the relationship between the generalized harmonic analysis of functions and of time series is complete.

The book begins with an introduction which describes the origin of the problem in communication engineering on the one hand and statistical theory on the other. Next there is a long and somewhat difficult chapter outlining without proofs the mathematical theories such as Fourier integral theory, generalized harmonic analysis and ergodic theory, which are used in the rest of the book in the discussion of the two main problems considered—prediction and filtering.

In the problem of prediction we suppose that the time series is known up to a particular point and it is desired to make a prediction of its future course. This prediction must be in some sense an optimum one and the criterion adopted is that of least squares. A key part in prediction theory is played by the theorem that for almost all functions of the ensemble, space averages over the observable part of the function (the past) are equal to space averages over the whole function. A similar theory is developed for the slightly simpler case of prediction and filtering for arrays, i.e. infinite sequences of the form $\ldots a_{-1}, a_0, a_1, a_2, \ldots$, which correspond to the discrete time series observed in economics and meteorology.

The problem of filtering is next considered; that is, the problem of separating a time series of known structure (the "message") from a superimposed "noise." This problem is not essentially very different from that of prediction, the latter being in effect carried out by a filter with negative lag. In both filtering and prediction the emphasis is laid on obtaining operations which can be represented, in a certain manner, by rational functions. The reason for this is that the operations can then be realized in practice by electrical filters whose structure is characterized by the appropriate rational function.

The book also contains a discussion of multiple series in which we have a matrix of covariance functions which is well known to the economic statistician and also appears in the theory of light under the name of "coherency matrix." There is also a short chapter on some miscellaneous problems such as that of approximate differentiation of time series. The book ends with three appendices of which the first is a table of Laguerre functions (useful in designing filters) and two articles by N. Levinson which expound Wiener's theory in somewhat shorter terms, and provide some additional results.

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This book has had, and will have, a large influence on the development of the subject, but it is not a treatise on stochastic processes and there are many problems to which the author does not refer. Very few references are given to other writers and Khintchine and Lévy are not mentioned at all. Similarly there is no discussion of sampling problems. The reason for this is that in communication engineering the series involved are either very long, or their structure is known in advance. Few concessions are made to the reader and most statisticians will find the mathematics stiff reading. There are a few misprints but the book is well turned out and the printing easy to read.

P. A. M.

3.—*Principles of Medical Statistics.* By A. Bradford Hill. 5th ed. London: *The Lancet*, 1950. ix + 282 pp. 8½″. 10*s.* 6*d.*

Only two years have elapsed since the publication of the greatly revised and enlarged 4th edition of Professor Bradford Hill's textbook, and in this new 5th edition the author has made few additions or alterations. Some new paragraphs on the principles of experimental design and selection of experimental material have been added, and in the chapters concerning methods of calculation occasional changes in presentation have been made. These changes are such that the exposition, while remaining elementary, does not now conflict in any way with more sophisticated ideas, nor leave any room for uncertainty in the mind of the reader. For example, the use of $\sqrt{(s_1^2/n_1 + s_2^2/n_2)}$ as an estimate of the standard error of the difference between two means is illustrated, and it is explained that this statistic "is difficult to defend logically, but arithmetically is convenient," and shown that this method usually gives much the same result as the more exact one.

The major addition is that of twenty-five exercises and solutions, which entirely fulfil the author's intention of enabling his readers to test their grasp of the arithmetical processes to which he has introduced them. Beginning with problems of tabulation and the calculation of means and standard deviations, the exercises proceed to the illustration of the characteristics of samples and to simple significance tests, the calculation of regression lines and correlation coefficients from grouped and ungrouped data, problems from life tables, and the calculation of standardized rates. All the exercises are such as are constantly met with by workers in clinical or preventive medicine, and the solutions are given in full, frequently with detailed comment and explanation. The medical worker who has sufficient interest in statistical method to take up the book in the first place, will find that when he has successfully completed these exercises he is comfortably equipped to make the most—and no more than the most—of the numerical data that comes his way.

There is one trivial arithmetical error in the solution to exercise 6, where the correction for the mean is wrongly given, and a more unfortunate slip in the solution to exercise 15, where observed instead of expected values have been used in the denominator of a χ^2.

P. D. O.

4.—*United Nations: Statistical Year Book* 1948, *First Year.* Lake Success, New York. (London: H.M.S.O.), 1949. 480 pp. 11½″. $6.00.

The last and 17th issue of the *Statistical Year Book* of the League of Nations appeared in May, 1945. After a lapse of nearly five years this new source book of international statistics is welcome. It is the first of a new annual series, compiled by the Statistical Office of United Nations, and as regards type, presentation, and arrangement of tables it is a great improvement on its predecessor. This first volume follows the general lines of the League Year Books (all headings and notes are bilingual—English and French), though it covers certain subjects such as national income, balance of payments, social, transport and education statistics which did not appear in the League volume, or appeared only occasionally.

It is impossible to review in a few paragraphs a volume of about 160 tables and nearly 500 pages, covering almost the whole field of official statistics of all countries. A few observations may be made, however, on the problems of presentation of international statistics which occur to the writer on perusing the present volume. "The aim of the Year Book tables," it is stated, "is to show for the various countries over the period covered, generally 1928 to 1948, continuous time series which are as nearly comparable internationally as the available statistics permit." The compilers of the Year Book have certainly made a laudable effort to achieve international comparability. In the first place, all index numbers, whenever possible and necessary, have been recomputed on the basis 1937 = 100. This greatly facilitates comparison of changes in time of the various series. Unfortunately many series have been started since 1937, and no shifting of base was possible. This is especially true of cost of living index numbers, where nearly half the series are on a base subsequent to 1937. In the League's *Statistical Year Book*, 1929 was taken as

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the common base year. This is now too remote, and 1937 is perhaps the best year to adopt, in view of the abnormal circumstances arising during the war and post-war periods. Secondly, all tables (with a few exceptions) are arranged uniformly in accordance with the standard "Nomenclature of Geographic Areas for Statistical Purposes" compiled by the Statistical Office of United Nations in 1949. This valuable publication, which is too little known, is obtainable free of charge from the Statistical Office, and a separate review of it is given below. Thirdly, wherever possible the grouping and order of tables which cover economic activities such as agriculture, mining, manufactures, etc., have been based on the "International Standard Industrial Classification of All Economic Activities" compiled by the U.N. Statistical Commission. This classification was described in a recent issue of this *Journal*.* In these three respects the Statistical Office has rendered a great service to statisticians in rendering international data as nearly comparable as possible.

There is one aspect of this volume which calls for comment. It is stated (p. 11) that "the basic data were obtained directly from the national statistical offices . . . or were taken from official publications," and it is added that certain other specialized agencies and inter-governmental bodies furnished the data for some tables, as well as a few private bodies (such as Lloyd's *Register of Shipping*). It is perhaps inevitable in a publication of this nature, compiled in close collaboration with governments, that data should be confined to those of national statistical offices, but this means that many statistical series compiled by non-official bodies have to be omitted. To take our own country as an example, the London and Cambridge Economic Service, the *Statist*, the *Economist*, the National Institute of Social and Economic Research, compile valuable index numbers of prices, production, wages, etc., which find no place in this volume. The *League of Nations Year Book* was more generous in this respect. No doubt it is impracticable to include all such series in the *Year Book*, but some warning might perhaps have been given to the reader that other accepted series exist. This is the more necessary, as the practice which the Statistical Office states has been adopted differs from that adopted by other international bodies whose tables are given in the *Year Book*. A number of tables are given which, it is stated, are data "furnished by the International Monetary Fund" or "by the Food and Agriculture Organization." These bodies have not hesitated to use unofficial data when official data are lacking. For example, Table 146 on "market prices of industrial shares" contains several series compiled by private bodies (although this fact is only rarely stated). In the case of the United Kingdom the International Monetary Fund does not hesitate to use for this table the series compiled by the London and Cambridge Economic Service, though the other valuable series published by this Service are not used in the tables compiled by the U.N. Statistical Office. Some of the figures in Table 12 (index numbers of agricultural production) also are not compiled by national statistical offices but are estimates made by the Food and Agriculture Organization. The series of Tables 156 to 158 on newsprint and newspaper circulation which are supplied largely by U.N.E.S.C.O. are apparently entirely unofficial statistics except for one entry in Table 158 relating to U.S.S.R., which figure, a footnote states, is "official." It would be desirable, therefore, that in future editions the sentence from p. 11 quoted above should be clarified and further information given on the use of non-official figures.

A valuable appendix gives a complete list of conversion factors and coefficients for weights and measures and for various industrial products in great detail—five different conversions from "paddy" to "rice" are given based on Indian, Pakistan, Korean, Japanese and Malayan practice—and another appendix indicates the subjects which are treated (often in greater detail) in other international statistical year books (I.L.O., F.A.O., I.M.F., etc.). Those treated in monthly statistical bulletins are not included. A summary of the contents of these would also be valuable; it might show, for example, the interesting fact that for the cost of living in the United Kingdom, "International Financial Statistics" prefers the series of London and Cambridge Economic Service (base 1937 = 100), while the Statistical Office prefers those of the Ministry of Labour (old series based on July, 1914 = 100, and new series based on June, 1947 = 100).

A list of the principal sources used, though no doubt a formidable task, would be useful to students requiring further details on scope and methods. Such a list is supplied, however, in the *International Labour Office Year Book of Labour Statistics* and in the *United Nations Demographic Year Book*.

Little information is given on the methods adopted in the different countries for the compilation of their figures. This, however, has been done by the Statistical Office in respect of the series, often identical, published in its *Monthly Bulletin of Statistics*, and it is surprising that no reference is made to this publication, which is entitled *Monthly Bulletin of Statistics, Supplement, Definitions and Explanatory Notes* (September, 1948).

* Beales, R.E., "Industrial Classification, National and International," *J.R.S.S.*, Vol. CXII, Part III, 1949, pp. 316–330.

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One of the most valuable tables on which the Statistical Office is to be congratulated is that on National Income. The League *Year Book* in 1945 included only eight countries on this subject; the present table covers 40, and though many of the figures are "non-official," or in some cases rough estimates, enormous progress has been made in this field since the war. Among the new tables which appear for the first time in an international statistical year-book are those on housing and illiteracy. It is interesting to learn that of the private dwellings in France in 1946 only 9 per cent. of the urban and 1·6 per cent. of the rural dwellings possessed bathrooms. (In Canada in 1941 the figures were 75 per cent. and 17 per cent. respectively.) It comes as a shock to learn that 49 per cent. of the population over 10 in Portugal (1940) and 57 per cent. in Brazil and Venezuela (1940/41) were illiterate. In India (1931) nearly 85 per cent. of the males and 98 per cent. of the females over 10 were recorded as illiterate.

This first volume of the *United Nations Statistical Year Book* is the latest example of the excellent work carried out by the Statistical Office of the United Nations Secretariat under the direction of Mr. W. R. Leonard, who is continuing the pioneer work of Mr. Campion, the Office's first Director.

J. W. N.

5.—*United Nations, Demographic Year Book*, 1948. Lake Success, New York (London: H.M.S.O.), 1949. 596 pp. 11¼". $7.

This weighty volume—literally, it weighs 4 lb.—is the result of a recommendation of the Economic and Social Council of United Nations in March, 1947, that there should be published "a demographic year book containing regular series of basic demographic statistics, comparable within and among themselves, and relevant calculations of comparable rates." Hitherto the only international publications of demographic statistics have been the *Aperçus de la démographie des divers pays du monde* compiled by the International Statistical Institute, of which the latest volume relating to the years 1929–1936 was published in 1939, and a short *Summary of International Vital Statistics*, 1937–1944, published by the United States Public Health Service in 1947. The need, therefore, for a new publication was urgent, and this volume, compiled by the Statistical Office of United Nations in collaboration with the Population Division, is a monumental work necessary to all students of vital statistics.

The format, type and presentation of the table are on the same lines as those of the *U.N. Statistical Year Book*, i.e. excellent, but the volume differs from that of the *Statistical Year Book* in two important respects. It contains a valuable introduction of 35 pages in which the scope, methods of compilation and definitions used in the different countries are discussed, and the various pitfalls mentioned to which attention should be paid. Secondly, it includes a bibliography of nearly 50 pages of available official publications, mostly since 1930, containing demographic statistics. This bibliography was prepared by the United States Bureau of the Census and Library of Congress. On the other hand, no country index is included.

The tables are grouped in seven sections: population, births, deaths, marriages, reproduction rates, life tables and migration. The periods covered vary from subject to subject. Most of the annual series cover the period 1932 to 1947; the more detailed tables (by age and sex, for example) cover the years 1936–47. One table (enumerated population and intercensal increases) gives figures where available back to 1900. With a very few exceptions and for "population estimates" only, all the figures in the Year Book are taken from official sources or have received official approval of the country concerned. The problem of unofficial statistics, which is important (see Review above) in the case of the *U.N. Statistical Year Book*, does not therefore arise.

Questionnaires were sent to 245 areas selected from the *Nomenclature of Geographic Areas for Statistical Purposes* and resulted in 166 replies. Many of these, however, covered total population only, and an interesting table is given showing the "coverage" of each table. This table shows the enormous gaps which exist at present in our knowledge of the demographic situation of the world. Numbers of births and deaths are given for 112 areas, crude birth rates for 94, crude death rates for 84, infant mortality rates for 85, expectation of life for 42, and reproduction rates for 26 ; and for population by age, sex and marital status, only 41. Figures are also given showing the "population coverage," from which it appears that for 38 per cent. of the population no figures are available of total births and deaths, for 40 per cent. no figures on infant mortality, and for 35 per cent. no figures for economically active population. For international migration no information is available for 55 per cent. of the population, and for migrants by age and sex for 88 per cent. of the population. Even for the fundamental statistic, population by age and sex information is lacking for about 35 per cent. of the world's population. This lack of data unfortunately arises in those countries where the need for such data is greatest.

No figures are given in the tables for world population, but the introduction gives a figure of 2,325,834,000 for 1947. No estimate of the margin of error, which must be large, is given, although

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an attempt has been made in an earlier publication—*World Population Trends* 1920–1947—to which a reference might have been made. The population of China (like that of the world) is given to the nearest thousand for 1946 and 1947, although no census data are available. The previous estimate in the League of Nations *Statistical Year Book* was more cautious, and gave 450 millions as a "general indication." It would be interesting to know how the figure of 463,198,000 for 1947 was arrived at (no source is given in the table or the bibliography).

The table on the expectation of life (42 countries) shows India in a unique position, as the only country in which the female expectation at birth is lower than the male, and the country with the lowest expectations, 26·91 years male and 26·56 years female (1921–1931). For the highest country, New Zealand, the figures for 1931 were 65·04 years male and 67·88 years female.

It will come as a surprise to many that the infant mortality rate of Roumania (over 180 per 1,000 births in recent years) is higher than that of India. J. W. N.

6.—*Nomenclature of Geographic Areas for Statistical Purposes*, prepared by United Nations Secretariat Committee for Standardization of Geographic Names. Statistical Papers, Series M, No. 1. Statistical Office of the United Nations, Lake Success, New York, 1949. 36 pp. and maps. $10\frac{1}{2}''$.

This pamphlet is compiled in three languages, English, French and Spanish. Its object is to provide "a systematic classification of geographic areas covering the entire world" . . . and "the designations have been made only for the purpose of establishing a list of names of areas appropriate for collecting and publishing statistical data and corresponding to statistics being received at the present moment." The classification is based, first, on continents (U.S.S.R. being treated as a separate area), secondly, on administrative areas within each continent. Independent countries are segregated from dependent areas, trust territories, international administrations, etc. Each area is given a code number: seven code numbers from 1,000 to 7,000 for continents; within each continent independent areas are coded 010 to 390; non-self-governing areas 400 to 790; trust territories 800–890; and other areas 900–990. The components parts of any named entity are indicated by a decimal code beginning with 0·1. Thus, Dahomey is given the code number 1440.1, where 1000 denotes Africa, 400 denotes a non-self-governing territory, 40 denotes French West Africa, and .1 denotes Dahomey. In addition, each area (other than independent countries) is given a "status code," indicating the mother country to which the area is attached, running from 01 for Australia to 40 for international. Dahomey is thus given the status code 04 (France). The "decimal code" does not seem to have been applied consistently. It is applied, for example, to the provinces of China but not to those of Canada, which are certainly "geographic areas" for statistical purposes. Each area is also given a map code (a letter for parallels of latitude and a number for degrees of longitude), which indicates the position of the country on one of the seven maps appended. These maps are remarkably clear, and give, in addition to the name of the country, the geographic code. Finally is given a complete trilingual alphabetic index.

This nomenclature has been put to practical use in the first issue of the United Nations *Statistical Year Book*, and it is to be hoped that all international and national bodies which publish statistics by countries (e.g. foreign trade, emigration) will base them on this standard nomenclature. Anyone using statistics of this kind will realize that the practices of different countries are confusing. How often does one see England or Angleterre in a foreign publication when United Kingdom or even Great Britain is meant? Even "continental" statistics are not uniform. Denmark, for example, includes Greenland in Europe in its migration statistics. Such terms as Latin America, Scandinavia are found in statistical publications without defining them, and all such terms are expressly avoided in this nomenclature. The designations omit terms such as "Kingdom of" (Norway), "Commonwealth of" (Australia), "United States of" (Brazil), etc., with two important exceptions. The U.S.A. is called "United States" and the "United Kingdom of Great Britain and Northern Ireland" is given as "United Kingdom." Current usage perhaps justifies this procedure, and to give "America" for United States of America is clearly impossible, but there seems no reason why in this case it should not be given its full title. In the case of the United Kingdom it has a serious drawback in that the term Great Britain nowhere appears in the nomenclature. Anyone using British official statistical publications knows that "Great Britain" is "a geographic area for (many) statistical purposes," and the term is in fact used in the United Nations *Statistical Year Book* and its *Monthly Bulletin of Statistics*. A foreign user of British statistics who finds a table headed "Great Britain" will find no help in this publication (nor often in the British source either). British readers familiar with these terms do not always realize the difficulties of foreign readers and the errors into which they fall by their lack of familiarity with the scope of such terms as United Kingdom, Great Britain, and England and Wales. But these are minor points of criticism in a work which for the first time classifies, codes, and gives a standard terminology in three languages to nearly 350 separate areas. J. W. N.

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7.—*Proceedings of International Statistical Conferences.* (*September* 1947.) Vol. II: *United Nations, World Statistical Congress*, pp. 275. Vol. IV: *Inter-American Statistical Institute*, pp. 618 (undated). Issued by the Joint Arrangements Committee, c/o Monumental Printing Co., Baltimore, Md., U.S.A.

In March, 1947, the United Nations Economic and Social Council on the recommendation of its Statistical Commission adopted a resolution convening a World Statistical Congress in Washington, D.C., in September, 1947. This resolution was inspired by the consideration that the International Statistical Institute had decided to hold its 25th Session in Washington at that time and, as no international meetings of statisticians had been held for about 10 years owing to the war, it was felt that a world-wide representative assembly of statisticians would be to the benefit of not only the participating members and organizations, but also of the United Nations, in view of the statistical work then being undertaken by the Secretariat and the specialized agencies. A Joint Arrangements Committee was set up in the U.S.A. which obtained generous financial assistance, chiefly from American sources; various international bodies agreed to hold their regular meetings at the same time, and as a result the United Nations World Statistical Congress became one of the inter-related International Statistical Conferences held from September 6th to 18th, 1947, and attended by over 600 participants. The results of these Conferences are now in course of publication, and two volumes have recently (1950) appeared.

Vol. II contains the text of the addresses given during the meetings of the World Statistical Congress. The papers are grouped according to whether they refer to the statistical activities of the United Nations and to specialized agencies; to recent developments in the statistical activities of national government; or to the international comparability of statistics, with special reference to demographic and national income statistics. The papers are given in the original language (English, French or Spanish), with a summary in the other two languages. A summary of the discussion on each group of papers is also given, but in English only. No resolutions were adopted, as the objects of the meetings were primarily informative. The volume gives a useful and comprehensive survey of the statistical work being undertaken, or envisaged, in 1947 both by international organizations and by governments, but the delay in publication has made many of the contributions now out of date.

Vol. IV is a record of the first session of the Inter-American Statistical Institute—a body founded in 1940 consisting exclusively of statisticians of the American continent. In addition to the papers and working documents submitted to the session, a large number of resolutions was adopted (40), many of interest only to the American continent. Thus 16 resolutions related to the 1950 Census of the Americas; this institute in 1944 assumed responsibility for the preparatory work for taking a population census on, as far as possible, uniform lines in all the countries of the American continent in 1950. Ten resolutions dealt with statistical training, while one important resolution, addressed to the American governments, recommended the creation in each country of a "National Focal Point," whose principal function would be the supplying of international organizations (governmental and non-governmental) with the information necessary for accomplishing their purposes. This institute since its foundation some ten years ago has already done valuable work in the encouragement and development of statistics in the Americas, and this volume is not only a tribute to the work already achieved, but gives a perspective of the tasks before it.

These Proceedings are being published in five volumes, of which Vol. I will be an introductory volume, Vol. III will be the record of the meeting of the International Statistical Institute, and Vol. V that of the Econometric Society. These are likely to appear during 1950. The delay in publishing these 5 volumes is due to the formidable task of editing all the documents. All the volumes are printed in India except Vol. IV, printed in Mexico. J. W. N.

8.—*Relative Prices of Exports and Imports of Under-developed Countries.* 156 pp. 7*s.* 6*d.*
International Capital Movements during the Inter-War Period. 70 pp. 3*s.* 9*d.*
Economic Survey of Latin America, 1948. 279 pp. 15*s.*
Lake Success: United Nations (London: H.M.S.O.). 1949. 9″.

It is interesting to look at this small sample from the United Nations production line, with a view to judging its statistical quality. All three studies deal with difficult subjects. The first is an examination of the post-war terms of trade of forty-four underdeveloped countries and areas. Since these include many of the principal primary producers, a major determinant is the terms of exchange between primary products and manufactures. To those who are mollycoddled by the Board of Trade, with its extraordinary efficiency and speed in producing foreign trade statistics, it comes as something of a shock to learn that a book published in December, 1949, can seldom carry its statistics further than 1947, and frequently stops at 1946. The former seems

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altogether too peculiar a year to use. But it is pleasant to find that the comparisons with pre-war days are with 1937 and 1938 separately. The differences may well startle some of those who think of 1938 as the " typical " pre-war year.

The conclusion of the study is that, although it is true that prices of primary products have gained relative to prices of manufactures, there is no evidence that the overall terms of trade of the underdeveloped countries were, in 1946 and 1947, any better than just before the war. This is partly because the underdeveloped countries themselves import primary products, often marginal supplies at high prices; and partly because some of the manufactures that they import (particularly textiles) have increased in price more than most primary products. One of the most interesting parts of the book is the detailed discussion of the changes for separate countries, which serve as an awful warning to generalizers. "The terms of trade of St. Vincent deteriorated as a result of relatively low export prices of arrowroot and sea island cotton and high import prices of salted fish, rice, lard, condensed milk and sugar . . ."

The reader who knows that the terms of trade of the U.S.A. and the U.K. had both deteriorated may perhaps find it a little difficult to believe that, on the average, 44 under-developed countries had gained no advantage in their terms of trade. It is true, as is pointed out in a useful appendix, that the indices used conceal important changes of composition; the dislocation of the war and the dollar shortage have caused a forced reliance upon more expensive sources of supply. It is also true that some countries, such as France and Switzerland, improved their terms of trade. Nevertheless, it would be useful to dovetail this work on underdeveloped countries into a larger review of world trade prices, to see whether the results being obtained are consistent.

The second study, of international capital movements, is for the most part a rehash, with commentary, of the League of Nations statistics on Balances of Payments; some gaps are filled in from other sources, though many of these were (one would have thought) equally available to the League of Nations. It is useful to have the figures available in a convenient form, but the user would be greatly helped by an expert commentary on their likely inaccuracies. Take, for instance, the international transactions of the United States in 1929: Goods and services +748 $ mn., gold −120, long-term capital −240, short-term capital −4, errors and omissions −384. One's uninformed guess would be that, since short-term capital movements are notoriously difficult to trace, most of the error should be regarded as arising in this category. Some countries, in fact, absorb the error into an item, "Other (chiefly short-term) capital." But it would be useful to know what are the suspicions of experts regarding the sources of the very large error terms.

It is difficult to judge the quality of the *Economic Survey of Latin America* without a detailed knowledge of that area. It is clear and eminently readable. The use made of statistics (there are over 100 tables) shows a refreshing readiness to prefer the gleams of moonlight to complete darkness; for there are few subjects on which even the major countries keep accurate and comparable figures. We learn, for instance, that Ecuador has never had a census of population, that Bolivia last had one in 1900, and Uruguay in 1908. Since birth-rates in the area range up to 45 and 50, and death-rates are recorded (though inaccurately) as low as 11, the task of projecting a population from a point 50 years back is impossible.

The Survey discusses the trends in industrial, mining and agricultural development, foreign trade problems, and the post-war inflation. It points out that industrialization has taken place without prejudicing the growth of primary production. In fact, it is possible for agriculture to expand on a falling or constant man-power, thus releasing labour for the developing industries. To judge from some of the indices of social conditions, such as the infant mortality rate, the pace of improvement in standards of living is considerable, but there is a long way still to go. The report only mentions incidentally the special problems of the Caribbean area, with its very high population densities and exceptional annual rates of growth; it is to be hoped that future surveys will give those problems more detailed attention.

C. F. C.

9.—*Demographic Survey of the British Colonial Empire.* By R. R. Kuczynski. Vol. II. South Africa High Commission Territories, East Africa, Mauritius, Seychelles. London: Geoffrey Cumberlege, 1949. x + 983 pp. 9¾". 75*s*.

The second volume of the Demographic Survey deals with the High Commission Territories: Basutoland, Bechuanaland and Swaziland; then the Dependencies: Kenya; Uganda; Tanganyaki Territory; Northern Rhodesia; Nyasaland; Somaliland; further Zanzibar; Mauritius and Dependencies; and finally Seychelles. The book contains invaluable information on population and population growth, composition of native and non-native population, fertility, mortality, migration and many other items.

It is impossible to do justice to this impressive work in a short review, or to deal with all the various areas, dependencies and colonies of British East Africa. Let us confine our attention to

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chapter six and glance at the "South Africa High Commission Territories," i.e. Basutoland, the Bechuanaland Protectorate, and Swaziland, the Territories which have been so much in the limelight lately in view of the suggestion that they should be transferred to and administered by the Government of the Union of South Africa.

In view of this claim, it is perhaps interesting to note how the population of these Territories increased in numbers under British administration. The native (Bantu) population increased in the period 1904 to 1936 from 347,731 to 559,273, not counting 101,273 (including 22,669 females) absentees at labour centres.

In the same thirty-two years the native population of Bechuanaland increased from 119,411 to 260,064, and those of Swaziland from 84,529 to 143,709. The author has little doubt that the censuses before 1904 were incomplete and that the estimate of 1901 understated the population—Whereas the 1904 census, in his view, was not wide of the mark. Since 1921 the yearly increase was not more than 0·8 per cent., as a considerable part of the natural increase in population was lost through emigration, which was caused by a greatly increased exodus of labourers.

The population increase since the beginning of this century seems, however, to have been a mixed blessing for the native population. The medical reports up to 1939 seem to indicate that, whereas formerly there was abundant opportunity of obtaining fresh meat by killing game and of obtaining sufficient milk, as the natives had their cattle near the village, there are now qualitative nutritional deficiencies through lack of protein.

Another adverse factor is that in Swaziland the major part of the land is now owned by Europeans. The Pim Report stated: "the Swazi natives grow about one-quarter of the foodstuffs required for consumption, the remainder being for the most part produced by European farmers while a little is imported. The average yield per acre of native land is about one-half that of land owned by Europeans."

During the twenty-five years between 1911 and 1936, polygamy has greatly decreased. Whereas in 1911 there were 18·7 per cent. of native husbands with more than one wife, there were only 11·4 per cent. in 1936. These figures apply to Basutoland only (no data concerning polygamy are available either for Bechuanaland or Swaziland). These percentages show a marked reduction of polygamy, if we compared them with statements of earlier writers on the subject, who, at the beginning of this century, stated that "almost all the heathen males possess two or three wives" in Basutoland. The author, however, remarks, that the prevalence of polygamy was usually then much overstated.

This may well be. However, in view of the lack of data for the early period, we can ill afford to dismiss statements of eye-witnesses, even if they are sometimes somwehat sweeping. Even now demographic statistics are scanty, as there is no compulsory registration for natives in any of the three Territories; provision for voluntary birth registration seems still to exist in Basutoland. In Swaziland, the Births, Marriages and Deaths Registration Proclamation, 1927, abolished compulsory registration for natives; they can, however, register voluntarily. In Bechuanaland there is no provision for births or deaths registration, even on a voluntary basis.

Though some demographic investigations, based on sample studies, were made in the past, there is, according to the author, "no evidence that any native birth or death has ever been recorded in any of the three Territories by either a European registrar or a Native Authority."

Dr. Kuczynski unfortunately died at the end of 1947. His daughter, Dr. Brigitte Long, who had been his assistant for many years, added the finishing touches to the valuable book.

M. J. E.

10.—*Patterns of British Life*. London: Hulton Press, 1950. 144 pp. 10¾″. 25*s*.

The *Hulton Readership Survey* has become much more ambitious in its latest publication. Instead of simply presenting the sort of information which advertisers like to have about the readers of different journals and newspapers, a bold attempt has been made to use the 1949 *Readership Survey* for the additional purpose of supplying details of the breakdown of the adult population of Great Britain by various general characteristics. A sample of 13,000 people stratified by sex, age, social class, size and type of locality, religion and marital status was investigated, and the results are given here in a series of tables covering a wide range of subjects. The demographer is given information on family composition and structure and on average family size; the economist is told things about housing, domestic servants, respective uses of gas and electricity, stocks of consumer durable goods, tobacco and liquor consumption which are not available, (or at any rate not easily accessible) elsewhere; and no doubt, the sociologist, in addition to the above, will be glad of enlightenment on such topics as numbers of pets owned, use of cosmetics, participation in football pools, the age distribution of cinema-goers, and (inevitably perhaps) the reading habits of the general public. The above list, though by no means exhaustive, illustrates the extremely wide range of topics covered by the investigation. In addition, supplementary tables from

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official publications are provided on such matters as population size, functional distribution of incomes, etc.

In view of the scarcity of information available through official or other regular channels on so many of these topics, any catch of this sort makes a good meal indeed for statisticians. At the same time, we should be foolish to feast without chewing, and indeed some of the courses must be examined rather carefully.

The questions which spring to the mind about the *derivation* of the information are many, for we are very much in the dark about the sampling technique employed. In fact, all we are told is (effectively) the composition of the sample by sex, social class and age, that "quota-sampling" was used, and that the field-work and tabulation, etc., were under the control of Research Services Ltd., and a few brief definitions of a "household," the different "social classes" and "regions." On such vital points as the methods of stratification, the exact methods of fulfilling quotas (e.g. the tendency, if any, for investigators to stay in the towns rather than go out on the moors, to select families which fitted easily into the pre-assigned social classes rather than those marginal to them), the sampling errors, the methods of calculating population values from sample estimates, etc., we are told nothing. Perhaps it may be assumed that those responsible for the more technically statistical aspects have read their Yates and the U.N.O. Reports on Sampling Surveys, since we are assured by Mr. Hulton in the foreword that it is "mathematically demonstrable that such a sample (*sic*, 13,000), properly selected, will not differ significantly from the total population in its characteristics or attributes" but we have no proof. Is this really excusable? There is, surely, nothing to lose and everything to gain by full disclosure of the techniques used. And the awful warning of the American Presidential election in 1948 is still too fresh in our minds to assume that quota-sampling, even when well handled, necessarily produces good results.

In the absence of material which might permit a reasoned judgment of the statistical methods used we have to fall back on indirect checks. Now, it must be said straight away that on most of these tests the Survey does seem to provide reasonable results. One point which may cast some light on the sort of accuracy to be expected is the comparison of the numbers of men and women reported as married (Table 9). The number of married women is said to be some 5 per cent. greater than the number of married men, comparing with a 1·3 per cent. discrepancy in the 1931 Census. One might perhaps expect the discrepancy to be greater in the aftermath of war than in 1931, and therefore the sampling error may well be less than this figure of 3·7 per cent. The tobacco consumption figures, when roughly corrected for Northern Ireland and cigars and snuff, seem to agree reasonably well with the aggregate consumption figures given in the *Monthly Digest of Statistics*. This is particularly satisfactory, as budget data on tobacco and liquor consumption have always been notoriously unreliable. The number of dogs reported (Table 15) is some 20 per cent. higher than the numbers of dog licences issued in Great Britain during 1948–9, but the official returns may not be infallible. Some apparent errors should be pointed out, however. On page 27 the statistics given of agricultural holdings supplied with electricity disagree with those of the *National Farm Survey*. Nor is the statement on page 39 of recent movements in U.K. wage-rates completely accurate; if, as seems likely, it is based on the Ministry of Labour estimates, it should be pointed out that these exclude important occupations such as coal-mining and agriculture, whose inclusion would raise the estimated percentage increase.

In considering the *presentation* of the information, a sharp distinction must be drawn between the tables and the text. In general the tables are clearly and unambiguously laid out. One or two criticisms can be made, e.g. what is the definition of a "holiday" in Tables 32–39, and would not Table 63 on cinema-going be improved if it also covered the attendance of those under 16? But these are only minor blemishes. The text is, however, entirely unworthy of the general statistical level. Not only is the style reminiscent of popular journalese, but in a number of cases there is no discussion of, or connection with, the supposedly relevant Tables. This concession to what is conceived to be popular taste is regrettable.

Despite these faults one must express gratitude for the information provided. Even if the "patterns of life" surveyed are not those most in need of illumination (the economist might well argue that he would like information on income distribution and asset holdings in preference to expenditure on holidays) and are the by-product of advertisers' needs, they are a very great deal better than nothing. Is it too much to hope that this example of the provision of cross-section data by private enterprise will spur our public authorities into similar action before we fall too far behind North America in this field?

A. R. P.

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STATISTICAL NOTES

British Official Statistics

The interim index of retail prices compiled by the Ministry of Labour and National Service, which rose from 113 to 114 in April, remained at that figure in May and June, although there was a fractional rise in May and a slight fall in June. The food index rose from 122 in April to 125 in May due to increases in the price of butter and oranges, which were partly offset by reductions in the price of fish, tomatoes and vegetables. It fell to 123 in June mainly owing to a drop in the price of eggs. There were also increases in May in the price of coal followed by a seasonal fall in the price of coal in June. There was a fall of nearly 4 points in the figure for drink and tobacco in May due to a general increase in the average strength of beer without a corresponding increase in price. The detailed figures for April to June were as follows:

(Prices at June 17th, 1947 = 100)

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Drink and Tobacco*	*Total*
Weights . .	348	88	97	65	71	35	79	217	1,000
April 18th, 1950	122·0	101·3	118·4	115·2	110·6	113·3	106·6	107·5	114
May 16th, ,,	124·5	101·3	118·7	116·4	111·0	112·9	107·9	104·0	114
June 13th, ,,	123·1	101·3	119·0	114·0	111·3	112·5	108·1	103·9	114

In publishing the figures the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e. to the nearest first place of decimals. The decimals are shown in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attributed to the decimals, and for any other purposes, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates which had been 110 (June, 1947 = 100) since January remained at that level in April to June. The following is a summary of the figures since June, 1947:

(Wage rates at end of June, 1947 = 100)

Date (end of month)	*Men*	*Women*	*Juveniles*	*All Workers*
June, 1947	100	100	100	100
Sept., ,, ...	101	101	102	101
Dec., ,, ...	103	103	106	103
Mar., 1948	105	106	107	105
June, ,, ...	105	107	108	106
Sept., ,, ...	106	108	109	106
Dec., ,, ...	107	109	110	107
Mar., 1949	108	110	111	108
June, ,, ...	108	111	111	109
Sept., ,, ...	108	111	112	109
Dec., ,, ...	109	112	112	109
Jan., 1950	109	113	113	110
Feb., ,, ...	109	113	114	110
Mar., ,, ...	109	113	114	110
April ,, ...	109	113	114	110
May, ,, ...	109	113	114	110
June, ,, ...	109	113	114	110

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The total working population and the numbers in civil employment at recent dates, compared with mid 1948 when the new series of man-power figures started, have been as follows:

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Mid-1948 . . .	16,057	7,089	23,146	14,945	6,981	21,926
Mar., 1950 . . .	16,074	7,229	23,303	15,136	7,108	22,244
April „ . . .	16,085	7,266	23,351	15,163	7,147	22,310
May, „ . . .	16,058	7,266	23,324	15,172	7,159	22,331

The total working population rose by 21,000 between March and May (a drop of 16,000 males and a rise of 37,000 females). The number in civil employment was 87,000 higher in May than in March.

The level of unemployment, which had been falling steadily since the beginning of the year, fell by a further 14,311 between April and May and by 32,678 between May and June.

Number of Unemployed Persons on the Registers of the Employment Exchanges of the Ministry of Labour and National Service

Date	*Men and Boys*	*Women and Girls*	*Total*
April 17th, 1950 . . .	234,963	94,022	328,985
May 15th, „ . . .	220,985	93,689	314,674
June 12th, „ . . .	201,771	80,225	281,996

The total for June includes 39,630 married women. The figures do not include registered severely disabled persons who are unlikely to obtain work except in special conditions.

It is estimated that the number of unemployed persons on the registers at May 15th represented 1·4 per cent. of the total number of employees insured under the national insurance schemes. The percentages in the various Regions ranged from less than 1 per cent. in the Eastern, Midlands, North Midlands and North Western to 2·6 per cent. in the Northern Region, 2·7 per cent. in Scotland and 3·4 per cent. in Wales.

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CURRENT NOTES AND NOTICES TO FELLOWS

The Trustees of the Houblon-Norman Fund, on the recommendation of the Advisory Committee, have made the following awards for 1950/51:

Fellowships.—Miss L. M. Brown, Lecturer, Somerville College, Oxford, 1947/50, "English Commercial Relations in the 1830's"; E. T. Nevin, Assistant Lecturer, University College of Wales, Aberystwyth, "The Mechanism of Cheap Money since 1932"; W. Woodruff, Lecturer, University of Nottingham, "History of the Rubber Manufacturing Industry."

Research Grants.—G. H. Copeman, Research Student, London School of Economics, "The Direction of Joint Stock Companies"; J. S. Fforde, Student, Nuffield College, Oxford, "The Federal Reserve System, 1945/49"; Professor P. Ford, University College, Southampton (Additional Grant), "Small Ports in the U.K."; W. C. E. Hartley, Bank Official (renewal), "History of Banks and Bankers in Yorkshire"; J. Lanner, Lecturer, University College, Cardiff, "Banking in Post-war Germany"; W. T. Newlyn, Lecturer, University of Leeds, "Currency and Banking in the African Colonies"; L. S. Pressnell, Assistant Lecturer, University College, Exeter, "Country Banking, 1780/1845"; J. A. P. Treasure, Research Student, University of Cambridge (renewal), "British Export Trade, 1939/49"; B. Walkden, Head of the Department of Commerce, Mining and Technical College, Barnsley, "Uniform Cost Accounting in Relation to Price Control."

An offer of awards for 1951/52 will be made early in 1951. Further information may be obtained from the Secretary, Houblon-Norman Fund, c/o The Bank of England, London, E.C.2.

The Review pages of the *Journal* lose much of their value if the notices are materially delayed, and Fellows undertaking reviews are asked to co-operate in reducing the period between publication and the review of books.

It would greatly assist the Honorary Editors if any Fellows of the Society who publish books of statistical interest would, on publication, ask their publishers to send a copy for review.

In considering the review pages of the *Journal* the Council has also decided that in future volumes such reviews will be signed in place of the present use of initials.

The President has appointed as his Vice-Presidents for the Session 1950–51, Mr. H. Campion, Mr. R. F. George, Dr. J. O. Irwin, and Dr. Percy Stocks.

The following Fellows of the Society were included in the Birthday Honours List of June, 1950:

C.B.—Mr. D. A. Porteous.
C.B.E.—Mr. R. F. Fowler, Mr. A. J. Turner.
O.B.E.—Lieut.-Col. R. W. Watson-Hyatt.
M.B.E.—Mrs. P. C. Bray, Miss E. Tanburn.

Mr. C. H. Spray has recently retired after nearly 50 years' service with Lloyd's Register of Shipping. He has been a Fellow of the Society for almost twenty-five years and has represented Lloyd's Register in that capacity since 1944. Mr. Spray has shown for many years his close interest in the Society's affairs and Fellows will cordially wish him many years of pleasurable retirement.

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OBITUARY

Simon Rowson, M.Sc.

By the death of Mr. Simon Rowson, last June, at the age of 73, the Society has lost one of its senior Fellows. He was elected in 1904, and served on the Council from 1910–11 to 1915–16 and on the Library Committee till 1919–20. He had three main statistical interests. He was prominent in the Joseph Chamberlain Tariff Reform controversy, as Chamberlain's statistical adviser and secretary of his Tariff Reform Commission. In this field Rowson contributed three papers on taxation and trade, and was awarded the Society's Guy Medal in silver in 1914 for his paper on the Trade of the United Kingdom read the previous year.

A second statistical interest arose out of his connection with Jewish Communal affairs. In fact his first paper, read in 1905, dealt with the vital and other statistics of the Jews in the United Kingdom, and he was the first chairman of the Statistical Committee of the Jewish Health Organization. The estimation of the population of a religious or racial minority in a free country where the census avoids questions on race or faith as savouring of persecution presents considerable difficulties. Rowson attacked the problem from the available full records of persons buried according to Jewish rites and their known age distribution. He assumed what was probably correct fifty years ago, that nearly all British Jews were buried in this way whether they had been orthodox or not in their lifetime. He made the further assumption that the age distributions of Jews during life and at death were similar to those of the general population. The weak point in the method at that time was that the Jewish population of the United Kingdom included many recent arrivals, and that many immigrant Jews proceeded to the United States after a time, and died outside the United Kingdom. The population became more stable forty years later, and Trachtenberg, who applied Rowson's method to estimate the Jewish population of London and the United Kingdom in the 1920's and 1930's, was on firmer ground.

Rowson's third interest was the film industry, and he gave a statistical survey of it in his last paper, read in 1934. He was able to tell the Society that a very large section of the population went to "the pictures" at least once a week, and a substantial fraction twice a week or more often.

L. I.

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STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Annals of Eugenics—

March 1950—The familial distribution of diabetes mellitus: a study of the relatives of 1,241 diabetic propositi: *H. Harris.* An analysis of the blood types and clinical conditions of 2,000 consecutive mothers and their infants: *K. L. Boorman.* Hereditary factors in peptic ulcers: *R. Doll* and *J. Buch.* The blood groups of the Icelanders: *J. A. Donegani, N. Dungal, E. W. Ikin* and *A. E. Mourant.* The sex ratios in sibships with special reference to Geissler's data: *H. O. Lancaster.* Recognition of the rare RH type RY in three generations: *A. Johnstone.* Weight and height of a population in 1943: *W. F. F. Kemsley.* Family size in some hereditary disorders: *S. M. de Delbue.*

Biometrika—

June 1950—Periodogram analysis and continuous spectra: *M. S. Bartlett.* Notes on continuous stochastic phenomena: *P. A. P. Moran.* Accident proneness: *M. Greenwood.* Organic correlation and allometry: *K. A. Kermack* and *J. B. S. Haldane.* The probability integral transformation when the variable is discontinuous: *F. N. David* and *N. L. Johnson.* How balanced incomplete block designs may be made to furnish orthogonal estimates in weighing designs: *K. S. Banerjee.* The power of the χ^2 index of dispersion test when Neyman's contagious distribution is the alternate hypothesis: *G. I. Bateman.* Power of the modified *t*-test (*u*-test) based on range: *E. Lord.* The use of mean range as an estimator of variance in statistical tests: *P. B. Patnaik.* Some notes on the use of range: *E. S. Pearson.* On the statistical independence of quadratic forms in normal variates: *A. C. Aitken.* Two combinatorial tests of whether a sample has come from a given population: *F. N. David.* Maximum likelihood and the efficiency of the method of moments: *L. R. Shenton.* Fiducial limits and the parameter of a discontinuous distribution: *W. L. Stevens.* Extension of the Neyman-Pearson theory of tests to discontinuous variates: *K. D. Tocher.* A simplified form of Sheppard's correction formulae: *H. O. Hartley.* Some theorems in least squares: *R. L. Plackett.* Weighted probits and their use: *A. N. Black.* Table of the probability integral of the *t*-distribution: *H. O. Hartley* and *E. S. Pearson.* A method of estimating the parameters of an autoregressive time-series: *S. G Ghurye.* A test for the serial independence of residuals: *P. A. P. Moran.* Efficiencies of certain linear systematic statistics for estimating dispersion from normal samples: *K. R. Nair.* Apparent correlation between independent series of auto-correlated observations: *G. Walker.* On the inversion of circulant matrices: *I. J. Good.* The effect of non-normality on the *z*-test, when used to compare the variances in two populations: *D. J. Finch.*

British Journal of Psychology (*Statistical Section*)—

March 1950—An application of factorial analysis to the study of test items: *P. E. Vernon.* A method for computing principal axes: *L. F. Richardson.* A statistical study of the Rorschach Test: *A. Sen.* Group factor analysis: *Sir C. Burt.* Factor analysis by maximum likelihood: a correction: *D. N. Lawley.*

British Journal of Sociology—

Vol. I (1950), No. 1—Social structure and the ruling classes: *R. Aron.* The application of social research: *D. V. Glass.* Social grading of occupations: *J. Hall* and *D. Caradog Jones.* Social attitude and social class: *H. J. Eysenck.* Social structure and politics in Birmingham and Lyons: *A. Briggs.*

Vol. I, No. 2—Social class of Cambridge Alumni: *H. Jenkins* and *D. Caradog Jones.* Problems and orientations of research in race relations: *L. Wirth.* Social structure and the ruling class, II: *R. Aron.* The trend of national intelligence: *Sir C. Burt.*

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Economica—

May 1950—The statistical approach: *M. G. Kendall.* Distribution of incomes in the United Kingdom in 1938 and 1947: *E. C. Rhodes.* Revealed preference and the utility function: *H. S. Houthakker.* Recent German contributions to economics: *A. T. Peacock.* National income, exchange rates and the balance of trade: *K. M. Savosnick.* United Kingdom public expenditure by votes of supply, 1793–1817: *W. M. Stern.* Over-employment: *A. C. Pigou.*

Eugenics Review—

April 1950—The primrose path: *A. S. Parkes.* Fitness and survival: *C. A. B. Smith.* A satisfactory population for Britain?: *Sir C. Arden-Close.* War and eugenics: *L. F. Richardson.*

Lloyds Bank Review—

April 1950—The economics of rent restriction: *F. W. Paish.* Wages in full employment: *S. R. Dennison.* British industrial production: *E. Devons.*

Review of Economic Studies—

Vol. XVI (3), No. 41—Some international aspects of British cyclical fluctuations, 1870–1913: *J. S. Pesmazoglu.* Economic theory and business behaviour: *D. C. Hague.* The use of polynomials to represent cost functions: *E. F. Beach.* On the theory of social accounting: *O. Aukrust.* Economic thought in the Soviet Union: *A. Zauberman.*

Vol. XVII (1), No. 42—Devaluation and the cost of living in the United Kingdom: *J. L. Burtle* and *W. Liepe.* The welfare basis of the marginal cost pricing principle: *N. Ruggles.* On optimum tariff structures: *J. de V. Graaff.* A non-additive measure of uncertainty: *G. L. S. Shackle.*

INDIA—

Calcutta Statistical Association Bulletin—

March 1950—Teaching—Consultation—Research. Indian Science Congress Proceedings. Indian Society of Agricultural Statistics—Annual Session. The problem of design of specifications: *D. N. Nanda.* Problems in partially balanced incomplete block designs: *K. N. Bhattacharyya.*

UNION OF SOUTH AFRICA—

South African Journal of Economics—

March 1950—The Union's priority rating system during the war: *J. W. Garmany.* The West Wits Line: *W. M. Walker.* National income and social accounting: *J. R. H. Shaul.* Trade in a Ciskei native reserve: *D. Hobart Houghton.*

UNITED STATES—

American Academy of Political and Social Science, Annals—

March 1950—Aiding undeveloped areas abroad. (Whole Number.)

Annals of Mathematical Statistics—

March 1950—Some principles of the theory of testing hypotheses: *E. L. Lehmann.* Sample criteria for testing outlying observations: *F. E. Grubbs.* Distribution of the circular serial correlation coefficient for residuals from a fitted Fourier series: *R. L. Anderson* and *T. W. Anderson.* Bayes solutions of sequential decision problems: *A. Wald* and *J. Wolfowitz.* On the distributions of midrange and semi-range in samples from a normal population: *K. C. S. Pillai.* The impossibility of certain symmetrical balanced incomplete block designs: *S. S. Shrikhande.* The sampling distribution of the ratio of two ranges from independent samples: *R. F. Link.* A note on the estimation of a distribution function by confidence limits: *F. J. Massey, Jr.* Significance levels for a k-sample slippage test: *F. Mosteller* and *J. W. Tukey.* Adjustment of an inverse matrix corresponding to a change in one element of a given matrix: *J. Sherman* and *W. J. Morrison.* A class of random variables with discrete distributions: *A. Noack.* The geometric range for distributions of Cauchy's type: *E. J. Gumbel* and *R. D. Keeney.*

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Bell System Technical Journal—

April 1950—Error detecting and error correcting codes: *R. W. Hamming.*

Biometrics—

March 1950—A procedure for quantifying subjective appraisals of odor, flavor and texture of foodstuffs: *J. W. Hopkins.* The significance of deviations from expectation in a Poisson Series: *R. A. Fisher.* The estimation of error in rectangular lattices: *P. M. Grundy.* The general theory of prime-power lattice designs, V: *W. T. Federer.* An application of sequential analysis to whitefish sampling: *G. B. Oakland.* The present status of biometry: *W. G. Cochran.* Teaching and education in biometry: *M. S. Bartlett.*

Econometrica—

April 1950—Joseph A. Schumpeter (1883–1950): *W. Leontief.* Rational behaviour, uncertain prospects and measurable utility: *J. Marschak.* Inversion of the Leontief matrix by power series: *F. V. Waugh.* The bargaining problem: *J. F. Nash, Jr.* The analysis of output under discrimination: *E. O. Edwards.*

Milbank Memorial Fund Quarterly—

April 1950—Changes in world consumption of calories and proteins over the last decade: *C. Chatfield, M. L. Scott* and *J. Mayer.* The relation of protein scarcity and modification of blood protein to tuberculosis among undernourished subjects: *J. Marche* and *H. Gounelle.* An experiment in the control of tuberculosis among negroes: *J. Downes.* International approaches to modernization programs: *H. W. Singer.* Foreign capital in economic development: a case-study of Japan: *E. P. Reubens.* Future adjustments of population to resources in Japan: *W. S. Thompson.*

Review of Economics and Statistics—

February 1950—Some aspects of exchange rates. (I) Exchange rates and exchange stability: *P. T. Ellsworth;* (II) Mathematical supplement: *M. Bronfenbrenner;* (III) Note on the measurement of elasticity of substitution in international trade: *J. J. Polak;* (IV) A reply: *J. Tinbergen;* (V) Devaluation with imperfect markets and economic controls: *A. Smithies.* The Robertsonian and Swedish systems of period analysis: *A. H. Hansen.* Effect of mergers on industrial concentration, 1940–1947: *J. Lintner* and *K. Butters.* How much unemployment? (I) Introduction: *S. E. Harris;* (II) Correction of Census Bureau estimates of unemployment: *R. Nixon;* (III) The definition of unemployment: *C. D. Steward;* (IV) The Census Bureau estimates of unemployment: *G. Bancroft;* (V) Adaptations of the unemployment concept. (VI) Unemployment statistics as a basis for employment policy: *G. L. Palmer;* (VII) Comment on the papers on employment and unemployment figures: *S. H. Slichter;* (VIII) Estimates of unemployment: some unresolved problems: *J. T. Dunlop.* Notes on the structure of wages: *S. H. Slichter.* Soviet statistics: *N. Jasny.*

Society of Actuaries, Transactions—

Vol. I, No. 1—The origin of the Society of Actuaries: *R. A. Hohaus.* The actuarial examinations: *C. A. Spoerl.* An 80-column punched card for mortality statistical purposes and the procedure followed in its preparation: *J. F. Ryan.* On the derivation of discrete interpolation formulas: *T. N. E. Greville.*

DENMARK—

Nationaløkonomisk Tidsskrift—

Vol. 87, No. 6—Karteller og koncurrence: *H. Brems.* Nationalindkomstens fordeling mellem samfundsgrupper: *E. Cohn.*

FRANCE—

Journal de la Société Statistique de Paris—

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Population—

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HOLLAND—

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Vol. CXIII.] [Part IV

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SERIES A (GENERAL)

PART IV, 1950

Movements in the Real Product of the United Kingdom, 1946–1949

By W. B. Reddaway

[Read before the Royal Statistical Society, May 17th, 1950, Sir George Maddex, K.B.E., Vice-President, in the Chair]

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Part I.—Introduction

This paper includes the first preliminary results of an attempt made jointly by C. F. Carter, Richard Stone and myself to measure the movements in the real product of the United Kingdom over the period 1946–1949. These figures are, however, still very tentative, and the main object of my paper is to discuss the problems involved in such an undertaking; I hope that the discussion will help us to improve the figures when they are revised.

To some extent this paper covers the same ground as the one which I delivered last August to the International Association for Research in Income and Wealth (Reddaway*), with which some Fellows will be familiar. I have drawn on that paper in various places, and I hope that this one is complete in itself; but in the interests of brevity I have stated various propositions rather baldly, and would refer Fellows who are interested to the fuller treatment given on that occasion.

Our objective may perhaps most easily be visualized as the construction on an annual basis of an index of "production" covering the whole economy and not merely industrial production. To put it another way, we have been trying to measure in real terms the year-to-year movements in the total output of the United Kingdom.

As with all projects of this kind, it was necessary to evolve much more precise definitions of the original broad concept before this could be satisfactorily translated into figures. Moreover, these definitions had to be framed with one eye on the usefulness of the resulting concept, and the

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other on the possibility of securing data which would reasonably conform to it. And the process, as usual, caused us to spend a great deal of time on discussions of fundamental issues, with conclusions which usually seem ridiculously obvious when they are once firmly stated.

Although the process of deciding on what we wanted to measure was inevitably intertwined with the search for means of doing so, I intend to follow the logical order of starting with the discussion of principles, and then pass on to problems of their application. In the first part I shall not hesitate to include principles which we have not been able to apply fully in practice; the nature of the data often decides what has to be done, but unless one is clear on the logical principles one frequently fails to make the best approximation.

PART II.—THEORETICAL ANALYSIS

II.1. *General Principles in a Simplified Case*

The general principles underlying our method may best be seen by starting with the simplified case of a closed system in which all problems connected with the Government are assumed away. They may then be summed up as follows:

(*a*) We start with the value of the product of the U.K. in the base year (1948), and divide it between the various "industries" in which it was created. (As will be seen later, the industries used for this purpose are not defined in quite the usual way, but that need not detain us here.)

(*b*) The "net output" set opposite to each industry is the difference between the selling value of its (gross) output and the value of its "input" (including "true" depreciation); it is lower than the net output as defined for census of production purposes, not only because of the allowance for depreciation, but also because *all* outside purchases are deducted, including services of all kinds, and not only materials and fuel.

(*c*) We then need, both for the output and input of each industry, one or more indicators which will reflect the proportionate changes, in real terms, between the base year and any other.

(*d*) This enables us to record for any year the value of each industry's output and input, measured at base year prices. The sum of the outputs, less the sum of the inputs, gives us the value of the total net product for that year at base year prices, and the ratio of these totals gives the movement which we require.

The only points of principle in the above which call for comment are the use of separate indicators for output and input, and the inclusion of depreciation as an item of input. The first follows the ideas originally developed, so far as I know, by Geary (Geary, 1944), and I think there is no doubt about its logic. The use of an indicator of changes in gross output to apply to a base-year figure of net output logically requires the assumption that each unit of output will always imply a constant quantity of input; this will frequently be a reasonable assumption, and it is one which we have made very freely, but the need to realize what one is really assuming increases greatly as one leaves the field of industrial production. If we follow the Geary technique it is obvious that, at least in our simplified case, the result is the same whether you work from the outputs and inputs of all the industries, or whether you work from the expenditure side of the national income tables and express consumption and capital formation at base-year prices.

The inclusion of depreciation as an item of input is a more debatable proposition. I think that on the whole the concept of *total output net of depreciation* is a more valuable one to study than total gross output, but the really decisive point was the question of data. This may sound strange, when "true" depreciation is notoriously a difficult thing to measure; but so far as year-to-year movements go it seemed to us that over a short number of years one could plausibly assume that it moved roughly with output, so that in effect our output indicators could be taken to apply to "output less depreciation." Since in most cases we use the traditional assumption that input also moves with output this means that we only needed to find the base year net output (as defined above) for each industry and apply our output indicator(s) to it. And it appeared that it would be easier to find the base-year net output after depreciation had been deducted than before.

As I have thus revealed in advance some of the wide gaps between our principles and our practice, perhaps it is right to conclude this discussion with an advance statement that the rather peculiar definitions of industries which we have adopted were chosen largely in order to make the sweeping assumptions more justifiable.

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Changes in External Circumstances

Before leaving our simplified closed system, it is useful to explore some of the implications of the technique described above. I want to start with the problem what (if anything) we are to do to allow for changes in external circumstances.

Firstly, so far as the aggregate index is concerned, the technique aims at measuring changes in the total quantity of goods and services which are produced. More strictly, we attempt to value the outputs and inputs of all industries at the prices fixed in the market place in the base year, so that the net aggregate (for a closed system) gives the total available for consumption or capital formation, also valued at base year prices. A comparison of these totals for different years may fairly be said to give index-numbers for the output of goods and services, but it does not attempt to say whether or not we are "better off" in one year than another; if a very cold winter raises the demand for fuel to keep us at the old temperature, and extra coal, gas and electricity are produced in consequence (e.g. by overtime working) without any reduction in other output, then the index will rise, even though our standard of comfort is the same as last winter—just as it would have done if the source of extra demand had been greater prosperity. If we want to make judgments about welfare, any changes in "needs" must be allowed for on the other side of the account. (The great importance of this point becomes clearer when we introduce the Government and varying needs for armaments, etc.)

Secondly, when we consider individual industries we must entirely rid our minds of any idea that the index must be "fair" to them, in the sense that a fall in their output (or even output per head) is always a matter for blame or conversely for a rise. It is obvious enough when we consider a case like agriculture: a small harvest will lower the index, whether it is due to a drought, or the farmers' laziness, or lack of demand for the product causing it to be left ungathered. Our index must measure the results achieved, not the amount of effort devoted to the work, and we are not concerned with stories of either hard luck or good luck. In effect, we can sum this matter up very easily: changes in circumstances which affect the ease of producing goods or services will get themselves automatically reflected in the index, both for the industry in question and for the total; those which affect our needs as consumers are ignored by the index unless they lead to consequential changes in output.

The Unit of Output

Our general principle calls for the output of each year to be valued at the prices of the base year. This raises some very formidable problems about quality changes, even in the case of physical production (e.g. tons of coal, numbers of tractors, etc.). I do not want to say more about these than that the principle should be to try to value the goods actually produced in, say, 1949 at the prices which they would have fetched if that quality had been on sale in the base year. But with non-material objects it sometimes seems difficult to see what is the "thing" to be valued, with or without allowance for quality change. To put the problem another way, it sometimes seems difficult to know how a change in the total amount paid for the output of some service should be divided between a quantity change and a price change.

It must be frankly admitted that where an industry sells a complex service it is sometimes very difficult to decide what it is that the customer really pays for. But the *principle* must always be to examine the normal form of contract, and to see what the implied unit of quantity is. We must not be led away by any concept of what is "really" useful to the buyer, or what "really" causes work for the seller; either of these may in fact determine the contractual unit, but they may well conflict, and our eye must keep firmly on "the criterion of the market place."

This is a very tricky subject, and I may perhaps be forgiven two examples, showing the "right" and "wrong" answers. As we shall see, the decision usually becomes important if external circumstances change, and this provides the link with the previous sub-section.

(*a*) In the case of *fire insurance on houses* one might wonder whether the industry's output should be measured by the number of policies issued, or the number of claims met, or the premiums collected, or the value (or number) of houses covered, or the amount paid in claims, or possibly some combination—all value figures being of course deflated in some way to allow for price changes.

The major reasons which would cause these possible indicators to show different movements

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would be changes in the frequency or seriousness of fires, and any lag in the adjustment of premium rates to this factor. Should the output of the industry be shown as rising "in quantitative terms" in years when fires are more numerous than in the base year?

The answer to this seems to be that under his contract the customer buys "cover for his house," and the unit of output is therefore "an insured house."* In a bad year for fires the industry will have to do more work (assessing claims, etc.), but we should no more regard that as implying a rise in output than we would count the extra work which a drought imposes on a farmer in carrying water for his stock. If the fire risk permanently increases, and premiums are raised, the householder is not buying *more* insurance, but *more expensive* insurance.

Quality factors are not important in this case, unless there are changes in the conditions of the policy, or (possibly) in the standard of prompt service in dealing with claims. In such circumstances we ought ideally to allow for the change in the quality of the insurance, in the same way as with any change in the quality of an average ton of coal.

(*b*) With *general medical practitioners* one might perhaps have wondered whether their output should be measured by the number of visits made, etc., or the number of cures effected, or the number of potential patients effectively covered (a concept explained below). Here again we must appeal to the criterion of the normal contract. Before the National Health Service, the visit (or something analogous) was the normal unit of quantity in contracts with private patients; there was an implied quality standard of professional skill, etc., but the doctor normally was paid for the work he had done, irrespective of how successful the results proved to be in any particular case. There were exceptions—e.g. a doctor might charge a fixed sum for whatever attention was needed in connection with a maternity—but in the main the patient had to bear the risk that a large amount of doctoring might be needed to produce the result which he really wanted (i.e. restored health). As a corollary, the output of the general practitioners would be shown, under this system, as rising whenever there was an epidemic.

Under the National Health Service, however (and previously for panel patients), the normal contract is different, and resembles the insurance principle. The doctor now contracts to supply whatever medical attention the potential patient may require during the year, and his output must therefore be measured in terms of the number of potential patients effectively covered. Epidemics no longer cause a rise in output measured in these units; indeed, since they are likely to mean a deterioration in the quality of the service supplied, they should lead us to record a fall.

These contrasting results† have been set out to stress the inherent futility of expecting an index of output to reflect movements both in welfare and in work done. It is fundamentally based on market concepts, which sometimes broadly reflect one, sometimes the other—but sometimes neither.

So long as the output of an industry is, in fact, sold to an independent buyer one can usually find some reasonably logical unit of quantity implied in the contract. When we come to the Government sector, in which the customer is often his own *entrepreneur*, we have to visualize the sort of contract which would most probably prevail if the Government employed a private contractor to do the job. The main body of the calculations relates to market phenomena, and the awkward parts should be made to conform to the same general principles.

II.2. *Problems Connected with the Government*

The introduction of Government operations complicates the picture in many respects—as is to be expected, since the Government behaves in ways which do not conform to market usage.

The first set of problems is connected with taxation and subsidies. On this I only want to say that our principle is to make all valuations at factor cost; this conforms to the normal index of production technique so far as major excise duties and subsidies are concerned (e.g. beer and sugar), but we try to push the principle to its logical conclusion by allowing for all indirect taxes and subsidies (including, as will be explained below, those given " in kind ").

* More strictly the houses have to be weighted by the premium payable in the base year, so as to allow for differences in both the value of houses and the risk factor to which they are exposed (so far as this was reflected in the premium rate). If insurance companies included a loading in the premia for small houses to allow for the higher expense ratio this would also be reflected.

† In our case half the base year comes under the National Health Service and half under the old system, which might be held to justify almost any system of measurement. Our use of the estimated number of general practitioners as an indicator would produce intermediate results in the case of an epidemic.

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The second set of problems arises out of those Government activities which involve the employment of factors of production, and so an output of services. Our treatment of these may be briefly summarised by saying that we divide them into three types (plus some hybrids):

(*a*) *Nationalised industries*, etc.—All commercial or semi-commercial operations (e.g. food importing) are treated on the same principles as private industries; in view of the transfers between government and private operation which have taken place during the period, any other procedure would produce very queer results, and the most natural indicators relate (for example) to the quantity of timber imported, irrespective of who was responsible.

(*b*) *Free services to industry*.—The essence of this category is that the Government activity is essentially designed to facilitate the output of goods or services which are covered by the figures for "ordinary" industries. The service may be rendered to a particular industry, e.g. the agricultural advice service, or to industry in general, e.g. employment exchanges.

If we take the agricultural advice service as our example, it is clear that its influence will be inextricably embodied in the output figures for agriculture. We could perhaps measure its output in terms of lectures given, questions answered, etc.; but if in some year this output were doubled it would be wrong to take credit both for the doubled output of advice *and* for the resulting increase in potatoes or milk.

In effect, the advice is an "input" item into agriculture, as well as an output item of the advisory service; it is analogous to fertilizers, and should equally be treated on Geary's principle. The fact that it is supplied free cannot make it into a "final good": it merely means that agriculture is receiving a subsidy in kind, and the base year prices at which we value all output should include an allowance for the free service supplied in that year, so as to conform to the factor cost principle. We can then complete the picture of input and output in each year both for agriculture and the advisory service.

The same principle applies to services to industry in general. In the base year we should allocate their cost between industries in whatever way we think best—possibly in proportion to net output; the valuation of each industry's output at factor cost will be raised accordingly, and the resulting higher prices should be used throughout the calculation. For all years (including the base) the input into each industry would include an item for the services which it received in that particular year, valued at base year prices.

This principle, though logically satisfactory, calls for a measurement of the value at base year prices of the output of each Government service in each year—and strictly speaking of its input too, to complete the picture for the industry of supplying the services. We can largely avoid this awkward statistical problem by treating the agricultural advisory service, for example, as part of agriculture. The "advice" then becomes an internal affair, which does not need to be included either as output or input. In effect our "industries" will then be defined as covering those activities which are designed to produce a certain output, wherever they are performed, rather than the traditional "groups of establishments"; this point is taken up in section III.1 below.

Where the service is rendered to industry in general the solution does not appear quite so neat, if we talk in terms of "industries"; for example, we have to say that we define the cotton industry as including that part of (say) the employment exchange service which is in fact devoted to serving it. Statistically, however, the procedure is simple—the "weight" (i.e. base year net output) for the exchanges is spread over the industries considered appropriate, and no indicator is needed for year-to-year changes in their activity. Logically, moreover, this helps us to avoid the fallacy of counting the effects of an increase (or decrease) in their activity twice over—once as a change in their own output, and again as an indirect effect on the output of other industries. In view of the possible variations in the scope of these Government services (including "controls") it seemed essential to get the system logically right on this point, though in fact the quantitative importance of the issue proved smaller than one might imagine from much of the discussion of the subject.*

(*c*) *Government final services*.—Our third category consists of those Government services which are not designed basically as assistance to producers, but rather as providing for the needs of final consumers or of the community as a whole. It covers a very wide range, from the Armed Forces to street cleaning, or from tax collection to education.

* The total net output of Government departments and Local Education Authorities which we transferred to "industrial" indicators in this way was only some £80 million.

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One point may usefully be stressed at the outset. We decided, very firmly, that compilers of national product estimates must not start querying the wisdom of political decisions, any more than they should query the wisdom of consumers' decisions in the market-place. We do not therefore ask ourselves whether people "really" want these Government services, any more than we ask whether they "really" want patent medicines, or boiled shirts, or new-look dresses. From the point of view of the industry the fact that the money is forthcoming in payment for the stipulated service is all that matters.

As these services represent something *additional* to the output of ordinary industry—i.e. something which is not also an input—we must treat them like other industries, giving them both a weight (equal to the base year net output) and indicators of year-to-year change in the volume of net output. The provision of the latter raises the question of the unit in which output is to be measured, which has to be tackled in the way indicated in the last part of section II.1 above.

To take an example, the output of the Armed Forces in peace-time is not to be regarded as zero, or as measured by the amount of security which they have created, or even by the amount of training done. Their prime function is to provide a stand-by force to be called upon if necessary; we may presume that a contract between the Government and a private "Army-providing industry" would stipulate the size and efficiency of the force which must be kept available, and an increased output of the industry would take the form of an increase in this size and/or efficiency. We would not say that the output of the industry had gone down "because its job was to provide a sense of security, and the sense of security clearly fell between 1946 and 1948"; the fall in the sense of security was due to a change in the political climate, which created a need for a larger output from the Armed Forces industry in the same way as a severe winter creates a need for more fuel.

With a service like street cleaning, we could visualise a contract which stipulated for certain streets to be swept (say) once a week, in which case the unit of output would be "one acre-sweeping"; or the contract might provide for the streets to be kept at a certain standard of cleanliness, in which case the unit would be "an acre-year of cleanliness." The two units would give divergent results in years when the frequency of sweeping needed for maintaining the standard changed.

In most cases it seems more natural to visualize the contract as framed in terms of units related to the work involved rather than to the contribution which the results make to the Government's ulterior objective. Tax collection provides an interesting illustration. If a contractor were employed to do the job the unit of output might be "an assessment made (of a standard degree of complexity)," or it might be "£1 million (at 1948 prices) collected." The latter may seem the natural way of measuring the "output" of a tax-collecting department, and in epochs when taxes were often farmed out we might have adopted it. But nowadays we instinctively assume that the nature and level of the taxes is to be decided by the Government—i.e. the customer—and these vitally affect the work needed to raise £1 million; if the industry's operations are so largely prescribed, it seems inevitable that the unit of output would be "an operation performed" rather than "a result achieved."

The fact that the output of most Government final services is logically to be measured in units which correspond fairly closely with the work involved in producing them does not, of course, automatically mean that we can measure changes in output from year to year by changes in the numbers employed. There is still scope, for example, for the productivity of the tax assessors to be increased by mechanization, better organization or training, or to be decreased by slackness or over-staffing in relation to the load of work. But these changes are likely to be much less dramatic than they would be if we measured output in terms of revenue collected and the standard rate of tax were changed, or the number of uneconomically small assessments were greatly reduced by a change in the law. We do in fact use wages and salaries paid (adjusted for changes in pay-scales) as an indicator of output changes over a large part of the Government field, in cases where we have no data on the number of operations performed; but if the latter is available—e.g. the number of pensions paid—we use it, since it is output rather than input which is our ultimate objective.

II.3. *Geographical Problems*

This section deals with the problems which arise when we relax the simplifying assumption of a closed system. Basically the difficulty is to know how to define the boundaries of the field of production to be studied; the existence of imports and exports causes no particular problem in

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itself, since for each industry we record (at least in principle) the output and the input, irrespective of destination or source.

Since it is *production* which we measure, the natural starting-point is a classification of "establishments" as either inside or outside the field. We cannot do this according to the proportion of the establishment's capital and labour which is "British": quite apart from problems of data, this might cause an enormous works to be sometimes included and sometimes excluded, according to the changing ownership of a few marginal shares. In the simple cases one clearly goes by the geographical position of the establishment; we include an American-owned factory situated in the United Kingdom, even if its workers are largely Irish migrants; we exclude a British-owned rubber plantation situated in Malaya.

As many Fellows will be painfully aware, however, "establishments" are often slippery things to handle, and an enterprise may have some in the United Kingdom and some abroad, which really collaborate to produce a joint output. Our Malayan rubber plantation, for example, is likely to be partly administered from a London office; how much heed (if any) is to be paid to the latter in our computations of "the product of the U.K."? And what are we to do with shipping and aviation?

A particular difficulty arises with Government operations. If we stick strictly to a geographical definition, then troops stationed in the United Kingdom contribute part of the U.K. product, but if they are moved to Germany or Malaya their activity becomes part of the German or Malayan product. This may be an acceptable result from some points of view, but it produces queer movements, and it also creates difficulties over data.

One's first instinct in tackling these problems seems usually to be to include too much in the U.K. product—in the sense that the rules would lead to the same activities being included in the computations of more than one country. Our own principles aim at avoiding this danger by following the geographical test as far as possible, with an extension of the area of the U.K. to include "extra-territorial rights" for H.M. Government wherever it operates in a non-trading capacity—e.g. to cover British embassies and oversea establishments of the Armed Forces—and a corresponding exclusion of foreign embassies, establishments of the U.S. Forces, etc., in the United Kingdom. The British flag on a ship or an aircraft (whether or not British owned) is also considered to make it a U.K. establishment, wherever it may be, unless it is wholly engaged in transport operations within the boundaries of some other country (including its coasting trade). Head offices and other establishments of international concerns are included, if situated in the U.K., their *weight* being an appropriate proportion of the 1948 net output of the concern, and their *indicator* being based on the activity actually performed in the U.K. from year to year.

The last sentence will readily be recognized as partly a declaration of principle rather than a record of achievement; the remainder seems to combine statistical practicability with conformity to one's ideas of what is logical.

Part III.—Statistical Sources and Procedures

III.1. *Definition of Industries*

Having reviewed the broad principles which the index-numbers should observe, I turn now to the question of assembling the necessary data, both on base year weights and on indicators of year-to-year movement. Of the two, we have regarded the securing of reasonably suitable indicators for the various industries as much the more important task, and we have laid out the work accordingly. In the main this has meant defining "industries" in a way that would fit in best with the data on indicators, even if that made the calculation of the weights more difficult; as will be seen below, we have relied very extensively on the dictum that when you are using 1,000 series moderate changes in weights make little difference to the answer.

It is not very easy to summarize the ways in which our industries have been defined as a result of following the above principle, but some examples may help. We started from the ordinary concept of industries, e.g. as used for the Standard Industrial Classification (C.S.O., 1948), but we have regrouped the establishments, or certain parts of their activities, on the following main lines:

(*a*) Government activities designed to assist an industry have been combined with that industry,

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in the way discussed above; similarly those designed to help industry in general have been "spread," by adding their weight to that of the indicators considered appropriate.

(*b*) Agents of many kinds—e.g. ticket agents, advertising agents—have been grouped with the businesses for which they work, so that the same output indicators serve for both.

(*c*) Various other firms whose output is almost wholly sold to businesses (and so constitutes an input element which would cancel out on aggregation) have been spread over the industries which buy their output; examples are accountants, industrial consultants, typing services, cattle-dealers. We have not, in fact, got any good indicators for movements in the output of most of these services, but even if we had the aggregate result would probably be rendered *less* accurate by treating them as separate industries, unless we also took steps to deal with the varying amounts of such services bought as input by other industries.

(*d*) In general, our indicators relate to the performance of certain *functions*, irrespective of who does the work, rather than the output of certain groups of establishments, and our "industries" must be defined accordingly. This is important, for example, as between distribution and catering: the indicator for cigarettes distributed covers those sold in public-houses and canteens as well as shops, and the catering indicator covers meals supplied in the tea-room of shops (or indeed by anyone with a catering licence). Where trades are so mixed, the weights must be adjusted to the base year activities, wherever performed, not to the establishments classified to a certain industry.

Perhaps more striking is the case of distribution and transport. Our indicators for road transport relate to the total activity of transporting goods, whether it is done by hauliers or in traders' own vehicles, and on the other hand, those for the distribution of goods do not distinguish goods which are delivered or collected by the distributors; we have no option, therefore, but to regard the transport work done by distributors (or, indeed, by manufacturers) as part of the road transport industry, and adjust the weights accordingly.

(*e*) In the case of building and civil engineering we have treated work of this kind done by the staffs of public utilities as part of the building, etc., "industry" whether it was maintenance or new construction. This leads to the weight for railway transport, for example, being reduced to allow for the "input" of track maintenance from the "civil engineering department," and the weight of building and civil engineering being raised. It gets over the disturbance to the index that would otherwise be caused if such work were sometimes done by contractors and sometimes by the utilities themselves.

In itself, the fact that our sectional index-numbers relate to certain functions or operations, rather than to groups of establishments, is probably an advantage rather than a disadvantage: they relate more nearly to "industries" as one would like to define them, if it were not for the awkward fact that establishments carry on overlapping activities.* It means, however, that comparisons between many of the sectional index-numbers and movements in apparently corresponding employment statistics are of little or no value.

III.2. *Determination of the Weights*

Without even a census of production for our base year, let alone a census of all business, the calculation of weights had to be done by indirect methods. In effect our procedure was to tackle the problem from both ends. On the one hand we attempted to set up "control figures" for the 1948 net outputs of the various Orders in the Standard Industrial Classification (or parts thereof), based mainly on information from the National Income White Paper (C.S.O., 1950), and to adjust these to our functional concept; on the other hand we attempted by a great variety of devices to produce rough estimates of the net output to be attached to each indicator, or to groups of these representing an industry. The totals of the individual weights coming within each Order was then compared with the control figure, and discrepancies reconciled by whatever method seemed most appropriate.

Our basic principle in arriving at the control figures was to deal separately with wages, salaries and profits (including interest and rent). The wage-bill was available for each Order, and for

* An outstanding example is the retailing of petrol and motor vehicles; this is nearly all done by motor repairers and garages, which are classified under manufacturing in the Standard Industrial Classification. Our "functional" treatment records this activity in its natural place, under distribution.

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many subdivisions. Some breakdown of the other items was also available—e.g. for agriculture —but for most Orders we had to make estimates from the wage-bill.

As a first approximation, we assumed that the salary bill for each industry for which we had no direct estimate would bear the same ratio to its wage bill as in 1938, for which year figures had been calculated by Miss A. Chapman at the Department of Applied Economics, Cambridge (Chapman*). Rather to our surprise, the total of these estimates plus the known figures agreed very closely with the White Paper figure for salaries, and the small difference was spread *pro rata*.

For profits, etc., we assumed as a first approximation, in cases where we had no direct information, that the ratio of these to wages and salaries would be the same as for the most nearly corresponding industry in the United States (Department of Commerce, 1949). The resulting figures were added up separately for broad groups of industries, between which we could estimate the split of the profits total on the basis of the White Paper figures. In this case some of the discrepancies in the sub-totals were very substantial, though the totals agreed moderately well. An inspection of the results and of a varied collection of alternative data convinced us that the division of the total given in the White Paper could not be accepted as a firm "control," and we selected those figures which seemed to agree best with the conflicting data available.

I shall not attempt to describe the methods applied to calculate the weights for individual series, beyond saying that they used such data as the census of production (1935 and 1946), accounts of public bodies (including, e.g., the Transport Commission, Local Authorities and the Government), the margins earned in distributing different kinds of goods, and earnings of various kinds of workers.

The resulting estimates of the weights are not quite so crude as the above bald summary might suggest, and various improvements are in course of being made. But this side of our work has little value in itself, and it would be a waste of time to attempt to do it very elaborately before the promised subdivision of profits by industries has been published, based on the inland revenue returns, and the census of production results for 1948 are available.

III.3. *The Indicators of Year-to-Year Movements*

The major part of our work has been the assembly of series which will indicate the year-to-year movements, in real terms, of the net output of the various industries. There is no systematic body of data which will serve this purpose, and it is a matter of eclectic opportunism to lay hold of the best that are available in each case. The consoling thought is, however, usually available that it is only *an indication of the movement* which is wanted, not a measure of the total, so that one can invoke the statistician's version of "the hidden hand"—the doctrine that economic series are often highly correlated.

As explained in section II.1 above, we have not usually attempted to measure the movement of input as well as output, but have relied on the assumption that their ratio (by volume) will be roughly constant over the period covered when industries are defined in our way. We have not made this assumption for building, however, nor yet for agriculture, where it would clearly be very dangerous in view of the varying amounts of fertilisers and imported feeding stuffs which may be used. In preparing the final version of the figures we hope to draw on other scraps of information which are available about the movements of input into various industries.

For the rest, I can only take the various indices *seriatim*, and comment on points which seem to be of interest, without giving a complete account of all the series.

Agriculture and Related Activities, Forestry, Fishing, etc.

The main component of this group is a consolidated series for agriculture and related activities, for which we are heavily indebted to the Ministry of Agriculture, who supplied us with much of the basic data needed for the computation. In effect, a ring fence is drawn round the national farm; transactions within the fence are ignored—e.g. inter-farm sales of hay—but everything going in or out (except capital goods) is valued at base year prices, and the difference, when adjusted for inventory changes, gives the required series of figures. These figures differ very substantially from the Ministry's own series for the net output of agriculture at constant prices, because the latter

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only deducts inputs of agricultural products (e.g. imported feeding-stuffs), whereas we have deducted fertilizers, tractor fuel and repairs, depreciation, and a host of other items. We decided, however, to group with agriculture a number of allied activities—e.g. dealing in livestock and home-produced seeds—by the device of including the performers of these functions within the ring fence, and so being able to ignore their transactions with the farmers; rather more dubiously, we also regarded veterinary surgeons as being within the ring fence, and added the specious argument that their services to the owners of pets could be off-set against their purchases of medicines, petrol and other input items.

The agricultural figures relate to years beginning in June, and have had to be adjusted rather arbitrarily to a calendar year basis. Otherwise this combined series comes closer than any other to the principles which we would like to adopt generally.

The remainder of the group calls for little comment, except perhaps to note that the activities of the British whaling fleet are included here. With the processing of the whales in the factory ships it is quite a significant item, despite the apparent absence of any reference to it in the Standard Industrial Classification. We clearly need to include it on our definition of the geographical boundaries, and we use the particulars given in the Trade Accounts for imports from British Whale Fisheries as our indicator.

Mining and Manufacturing

The principles underlying these groups are basically the same as in our monthly index of industrial production, which has been described at length elsewhere (Carter *et al.*, 1948). As only one calculation had to be made for each year, however, we incorporated a large number of extra series which either were not available at shorter intervals, or did not seem to justify the extra work involved in a monthly computation. An interesting example of these refinements is the use of separate figures for the different classifications of coal—e.g. to distinguish "anthracite" from "slacks and smalls." The coal series carries such an outstandingly large weight that even a small percentage error in it makes an appreciable difference.

One important change of a different character was, however, needed. Our monthly index is defined as excluding the output of finished munitions and a few other items (e.g. all repair work except ship repairs). As the new computation aimed at covering the whole economy these omissions could no longer be justified. We therefore used the Estimates and Appropriation Accounts to devise a series for Government expenditure on the things which we had regarded as munitions, and adjusted it for assumed price changes. This series related to fiscal years, but in view of the lag between production and payment we have taken it as appropriate to calendar years. The whole device is a very poor one, and is liable to serious error as a result of varying time-lags in payment, but seemed to be the best available.

Building and Civil Engineering

This series is based mainly on the information which the Ministry of Works collect for the value of this kind of output, adjusted for changes in price. However, the ratio of output to input varies very substantially from one kind of work to another, and may also change significantly from year to year for work classified under the same broad statistical heading. To make some allowance for these two complications we have also attempted an estimate of year-to-year movements in the volume of input, based on the quantities of the main materials available in each year, and applied this to the estimated value of the input in the base year. In as disturbed a period as 1946–49, with methods of construction and types of work changing so greatly, it seems highly desirable to attempt an assessment of input as well as output for an industry of this size.

The Ministry of Works aim at covering all building and civil engineering work, irrespective of who does it. They can, however, only make estimates for the amount done to their own premises by ordinary manufacturers, etc., who take on no outside contracts, and we decided to omit this type of "output." The great bulk of it is maintenance work of a routine kind which would also count as an input to the firm's manufacturing account, and is basically similar to the maintenance work on machinery, which is not counted as either output or input.

We also excluded from this heading open-cast coal production (included with mining and quarrying) and pre-fabrication (included under manufacturing).

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Gas, Electricity and Water

Perhaps the most striking point about this index is the small weight it carries. This is the consequence of two factors:

(*a*) Our weights are based on "true" net output—i.e. after deducting depreciation, which is a large proportion of the "census of production net output" for these undertakings.

(*b*) We have transferred all the work of the civil engineering staffs to the previous series—whether it consists of maintenance or new construction. This means that in calculating the weight we must make a deduction from the sales proceeds of an input item equal to the value of the maintenance element, as well as any maintenance work done by outside contractors.

This is one of the fields where we hope to be able to make an annual assessment of the main input items, instead of relying on the assumption that they move proportionately to output.

Transport and Communication

The quality of the information available in this sector varies greatly.

For *railways* there is an abundance of operating statistics. We decided that the different types of passenger travel (e.g. season ticket, monthly return, full fare, excursion) must logically be treated as separate commodities, since they had a different price per passenger-mile in the base year, even though one might be tempted to say that they are all "really" the same thing; we have therefore valued the number of passenger miles in each category for which statistics are available at its own base year price, and added the results to get the volume of output in this section. Similarly for goods traffic we have taken the ton-mile figures in the available categories, and valued them at base year prices. Subsidiary items of receipts (e.g. parcels) have been adjusted for changes in tariffs and included; although they may seem relatively small compared with the main traffic items, they are quite large in the aggregate compared (for example) with some of the manufacturing items.

We have not attempted to make any adjustment for the improving quality of the service, as trains became less crowded, etc. Logically one is needed, but practically there seems no way of making it, since the alternatives of more or less crowded trains were not effectively available side by side.

We may attempt a measurement of *input* movements for the final version of the figures. It is open to the possible objection, however, that a reduced amount of crowding in trains implies *both* a higher ratio of input to output, *and* a higher quality of output; to correct for the former and leave the latter untouched might well increase the net error in the answer.

For *road passenger transport* we have based our indicator on the series of expenditure figures at 1948 prices, compiled for the National Income White Paper. As we wanted to study the whole output of the industry, we used an estimate of total expenditure (including the amount charged to business expenses), but the year-to-year movements were essentially similar to those in the published series. The information behind these figures is not as complete as one would like, but was clearly the best available.

For *goods transport by road* our main source of information was the figures of the number of goods vehicles licensed in each year, classified by type of licence (A, B, C, etc.). We gave each class a weighting factor based on the average unladen weight for that class in 1948, which damped down the effect of the rapid rise in the number of C licences. Even so the rise was a great deal steeper than is suggested by the best estimate available of the petrol consumed by goods vehicles; this result is compatible with the thesis that the large rise in the number of vehicles would imply, on the average, both less intensive use and a lower petrol consumption per mile. For our purposes this suggested a compromise between the two series as the best approximation, but clearly the margin of error is substantial.

For *sea transport* we were reluctantly forced back on the tonnage of British ships afloat as the best indicator available, with a division between tankers and others. Several other promising indicators were investigated which seemed more closely related to "output," but all seemed to suffer from some serious defect. The varying proportion of the fleet's takings derived from traffic between ports outside the U.K. was usually the stumbling-block.

For *air transport*, on the other hand, there is a mass of statistics on the operations of the main British companies, from which we selected revenue passenger-miles, mail ton-miles and freight

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ton-miles to represent output; for the independent operators we can only use the aircraft miles flown by members of the Air Charter Association. We also needed to cover the activities of the airports, which have to handle foreign aircraft as well as British; for this we use a series which approximates to the number of landings on U.K. aerodromes by civilian aeroplanes.

For most of *postal, telegraph and wireless communication* there is a good supply of suitable indicators in the Post Office Commercial Accounts. We used such series as the numbers of letters posted, parcels handled, telegrams sent (inland and foreign separately), local and trunk calls made, and postal orders issued.

The industry of *storage* we have transferred to distribution, because in nearly all cases the indicators which we use to represent the volume of goods distributed can rightly be considered to cover the storage which is in fact found necessary. There is a point of principle here, which, as usual, resolves itself into the fact that we ought to be measuring input as well as output. The fact that meat remains in store for a longer period now certainly implies that the output of the storage industry has risen, but it also implies that the input of storage services into the distributive industry has risen. We should only record a rise for the two taken together if the product emerging has improved with storage, as in the case of whisky or wine; for the maturing of these we use the level of stocks in bond as an indicator.

Distribution

Our treatment of distribution falls naturally into three parts—finished consumer goods sold in the home market, exports and the rest (largely industrial materials and machinery).

For *consumer goods* the basic indicators are the series compiled for the National Income White Paper to show the volume of goods of different kinds distributed; as in the case of travel, we require the figures before the deduction of goods purchased for business use. The different kinds of goods do not, however, all represent the same amount of net output by the distributive trades per £1 million of sales, so that we cannot simply take the total value at 1948 prices as our indicator for the whole of this section. For each category of goods which was distinguished we estimated the proportion of the 1948 final price which representated net value added by the distributive trades, apart from that which was attributable to their transport work—the latter being regarded as part of the transport "industry," for reasons discussed in section III.1 above. These proportions then served as weighting factors to apply in combining the values (at 1948 prices) of the various categories.

Three points are worth noting in this connnection. Firstly, we cover wholesaling and retailing in a combined operation. It might appear that we ought to separate them and move the wholesale part with wholesale sales instead of retail. In so far as retail stocks change in any year this would be a clear improvement, since the outputs of wholesaling and retailing will move differently. In so far as the proportion of the trade passing through wholesalers changes, however, the separation would usually produce a distortion in the final index. If, for example, a large retailer stopped using the services of wholesalers and set up his own buying department we should not want to record a fall in output (unless the quality of the service rendered to the public fell). In effect this is another illustration of the need to measure input as well as output: the output of the wholesale trade would have fallen, but so would the input of the retailer. Consolidation is a means of reducing the hazards involved in measuring output only, and assuming input to move proportionately.

The second point concerns quality. In principle we should adjust for changes in the quality of the service rendered by the distributive trades with each unit of goods. There obviously have been substantial improvements over the period, especially as we need to allow for the increased range of effective choice made available; but we have not attempted to make any adjustment. Our treatment of the transport element, however, automatically allows for the increase in delivery services.

Finally, we may note the effect of our having included the work of Government Departments on price control and rationing in the weight of the distributive trades. The abolition of clothes rationing provides a good example. Here our figures record that the combined output of the rationing department and the clothing distributors rose by 6 per cent. between 1948 and 1949, since the volume of clothing distributed rose by that amount; the fact that rationing existed in

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1948 and not in 1949 is irrelevant, so long as we accept the tacit assumption that the quality of the distributive service was equally good in the two years. This does not, of course, imply that the rationers were doing no good in 1948 or earlier years; the abolition of sweets rationing showed that in certain circumstances the quality of the service can deteriorate violently if the distributors lose the help of the rationers. But in this case a change in external circumstances (the disinflation policy) greatly facilitated the task of distributing clothing in a satisfactory manner and made the rationers unnecessary; it is perfectly correct to show a rise in output per head for the combined industry, without of course implying that it deserves any particular credit for it.

Our treatment of "*export distribution*" is at present very crude, and it is not obvious either what the exact objective should be or how to attain it. Clearly the operations of the export merchant or other intermediary are part of the real product of the United Kingdom, except in so far as they are conducted in oversea establishments. But in so far as his remuneration takes the form of a discount or commission deducted from the manufacturers' normal price, our output indicator for manufacturing more nearly reflects changes in the combined output of producer and agent; on this basis we want to ensure that the weight covers both, but do not need a special indicator for the exporter. On the other hand, export distribution, even when carried out by the producer, may involve extra packing and selling; if this were reflected in a higher price in the base year, then we should by one means or another show a rise in output if the proportion exported rises—the simplest method being to keep the ordinary series based on total output for "production," and to introduce a second series based on exports to represent the extra net output involved in exporting. In this way a series based on the volume of recorded exports will approximately cover the function of "export distribution," whether it is performed by the producer himself or by an intermediary.

For the moment we have adopted the device mentioned above, in the crude form of a series based on the total value at 1948 prices of exports and re-exports. We have a note in our files that this should later be split by commodities and/or markets in accordance with the varying proportions of additional net output, but at present this seems likely to remain a pious aspiration.

The distribution of *industrial materials and machinery* is represented by a number of series showing the consumption or home supply of items which require a substantial amount of distribution—notably coal, petrol, cloth, flour, builders' materials, fertilizers, agricultural machinery and motor vehicles of all kinds. Where the same goods are also bought by final consumers we have sometimes treated the whole work of such distribution in one place—e.g. for coal, where we used a set of weighting factors for the differing amounts of net output involved in a ton delivered to, e.g., a domestic consumer and an electricity undertaking; in other cases—e.g. cloth—we have treated the distribution to makers-up quite separately from the sale to final consumers of dress materials and furnishing fabrics.

This sector is most important in cases where the users of the material are numerous and buy in relatively small amounts (e.g. bakers, builders, farmers), or where the material is produced in relatively small quantities by a large number of producers (e.g. malting barley) and so needs a lot of assembling. The last case leads naturally to the special form of "distribution" which is more naturally called "collection"—the trade in scrap metal, waste paper, etc. Here we use such indicators as the consumption of waste paper, rags, old rope, etc., by the paper-makers.

Insurance, Banking and Finance

This sector requires careful consideration of the basic concepts. Our definition of the net output of an ordinary manufacturing or service industry includes the whole earnings of the "capital" employed in it, using that term in a wide sense to cover money borrowed from a bank as well as share capital. This is in accordance with the normal practice of national income statisticians (Stone, 1947), and I only mention it here in order to stress the corollary that neither the interest on bank loans nor the dividends on the investments of insurance companies can be counted as part of their "output."

The case of *fire insurance* has been discussed above (section II.1). The indicator which seems to give the best approximation to the required series for the "volume" of goods covered is premium income, adjusted both for changes in prices of the things insured and also for changes in the rate charged per £100 of cover. There are difficulties at all stages: the published figures for premium income do not cover Lloyds' underwriters; the price factor for the varied types of

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goods (stock-in-trade, buildings, etc.) is very uncertain; and we have only impressionistic data about the changes (or rather lack thereof) in premium rates. For houses we considered the alternative of taking the number of dwellings standing in each year, on the assumption that a constant (and very high) proportion would be insured. But this comes up against two snags: houses may not have been equally fully insured in each year, owing to lags in valuation changes; and, more seriously, the premia paid for houses cannot be eliminated from the total figure, so that we could not then do the residue.

The same principle of doubly adjusted premium income seemed appropriate to several other forms of insurance (e.g. marine, accident), though in fact we sometimes sought to achieve much the same result by a different route—e.g. by taking the number of motor vehicles with licences current, adjusted in 1948 and 1949 for the number which received no supplementary petrol and so only paid 60 per cent. of their insurance premium. With life assurance, however, there are two complications: the contract is a long-term one, so that we have acute problems about what might be called "work in progress"; and it is designed to provide a means of saving, as well as cover against the risk of premature death. We tackled these two problems by splitting the transaction up and giving the weight partly to the value of new policies issued, partly to the value of the funds managed, and partly to the value of all transactions with policy holders—all values being adjusted for changes in prices, but not premium rates.

In the case of *commercial banking* we regard the output as consisting mainly in services to depositors (clearing cheques, etc.), and partly in the management of the funds for which they are responsible.* The principal indicators are, therefore, the number of cheques paid (deduced from stamp duties received) and a "management percentage" of the deflated value of their various types of assets—the percentage being highest for advances and very low for such things as Treasury bills. The services of the executor and trustee department have to be transferred to professions, since the only indicators available reflect movements in the total output of such services; and similarly, the banks' services in connection with changes in clients' investments are merged with those of stockbrokers. On the other hand, the weight of the Banking Department of the Bank of England is added to that of the commercial banks, on the argument that its main function is to facilitate the smooth working of the system.

Savings banks are similarly given indicators based on the number of deposits and withdrawals made and the deflated value of the funds managed; the making of new issues is represented by the sums raised, adjusted for changes in the prices of capital goods; and the work of transferring existing securities from one holder to another is, at least temporarily, represented by the number of markings on the London Stock Exchange.

Real Estate

This series covers two types of activity. Firstly, we have to include in the real product of the United Kingdom the output of what we might call the "house-owning industry." The rents of industrial or commercial property have already appeared as part of the weight of the products made in them; if we made the provision of such premises into a separate industry we would have to ensure that its output was all duly deducted again as input into other industries, not only in the base year but in all others. The "housing" or "accommodation" provided by residential property, however, has to be separately included. Moreover, we follow the usual convention of regarding the owner-occupier of a house as renting it from himself, so that *all* dwellings need to be included, and not only those which are let; if services are provided by the landlord—e.g. a porter for a block of flats—these are also included here.

For the above part of this group we use as our indicator the National Income White Paper's series for the value at 1948 prices of consumers' expenditure on rent rates and water charges. In effect this amounts to taking movements in the gross schedule A value of all dwellings occupied in each year, and assuming the auxiliary services to move similarly.

* The major part of these services is rendered to businesses, and so needs to be treated also as an input item. We have not attempted to allocate it between the different industries, but have shown it as a deduction at the bottom of Table 1. (Unless some special treatment is adopted for the banks in allocating the national income according to its industrial origin, they are shown as making enormous operating losses, covered by outside income from investments; see Stone, 1947, mentioned above.)

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The second type of output covered by these index-numbers is the services of estate agents and the like in connection with sales, leases, tenancies or valuation of all kinds of real property. For this we rely mainly on estimates of the value of sales and leases based on the stamp duty figures, which we adjusted for changes in property values; on the argument that many valuations not connected with sales arise out of probate work we include a series for the deflated value of real property assessed for death duties.

The Armed Forces and Miscellaneous Government Services

These two series together cover the residue of the activities of the Central and Local Governments, after we have removed education, health services and all commercial or semi-commercial operations to their appropriate industrial group, and spread the services rendered to industry over the relevant industries. Very roughly, the two series cover the classical activities of Government in providing the essential conditions in which the community can function—security against aggression, law and order, an apparatus of Government, etc., together with the administrative machinery needed to run the welfare State—tax collectors, pension payers, etc.

The series for the *Armed Forces* consists simply of the National Income figures for pay and allowances of the Armed Forces, plus the wages and salaries of civilian employees of the Defence Departments, both adjusted for changes in pay-scales. It is worth noting that this method of procedure may show a different movement from that which one would get by taking the numbers in the various ranks, because it automatically rates a man who receives additional pay on account of long service, proficiency, etc., as equivalent to more than one raw recruit. As our objective was to measure changes in the size and fighting efficiency of the Forces, it seems quite right that a higher percentage of inexperienced men should show as a fall; we have not, however, been able to make any allowance for changes in the quantity and quality of the equipment available per man.

The main constituents of the other index, and the indicators used, are as follows:

Police and fire service—numbers employed.

Tax collection—wages and salaries, deflated.

Payments of pensions, national insurance benefits, poor relief, etc.—number of payments made to different classes of recipients, and numbers of contributors for whom records must be kept.

Control Commission for Germany—wages and salaries, deflated.

Refuse collection, sewerage—estimates of total population served, with loading factors to represent increasing frequency of collection and the rise in industrial effluents.

Various central and local administrative services—wages and salaries, deflated.

Law Courts—numbers of cases in different classes.

The case of *national insurance* was of some interest, because of the change of system. We were in some doubt as to whether one could reasonably carry any indicators through the period, or whether it would have to be treated as the discontinuance of one form of output and the start of a new one, with no basis of comparison between them. But it seems that the total weight to be attached to this group of activities would be much the same under both regimes (including the approved societies up to 1948), and the indicators are in a sense continuous. The only modification which seemed necessary was to treat a payment of sickness benefit under the new dispensation as equivalent to 1½ under the old, to allow for the inclusion of dependants' benefits.

It is perhaps of some interest to note that the total weight represented by numbers employed or by wages and salaries in the two Government groups together was only 5½ per cent. of the index. There are undoubtedly logical difficulties about the concept of "the quantity of output" in many of these cases, but they are not of great quantitative importance. As will be explained in Section IV.3 below, the great bulk of this output represents what we have called "regrettable necessities," and does not feature in the residue when these are eliminated.

Professional Services

The Standard Industrial Classification includes in this Order a number of industries whose output is almost wholly bought by businesses—e.g. accountancy, advertising agencies, trade associations; these have been combined with the industries which they serve, in the way discussed in section III.1, and so do not have any indicators of their own.

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For *education* one can see from the private sector that the basic unit of quantity is a pupil attending school for a term, and not, for example, the amount of tuition needed to enable him to pass a certain examination. There is, however, an important quality factor, which is clearly apparent in the differing scales of fees in different schools, and we felt that it would be better to make some allowance for one important aspect of this for which some sort of measurement is possible—i.e. the size of classes. This we did by introducing as a second indicator for each type of school the number of teachers, and giving it half the weight.

The main activities of the *legal profession* are assumed to be as follows, and represented by the following indicators:

Court work—represented by a series based on the numbers of cases of different kinds mentioned above under Government.

Conveyancing work—represented by the series based on receipts from stamp duties, mentioned under real estate.

Probate work—represented by the number of grants of probate.

The *medical and dental services* presented some of the most formidable difficulties encountered in the whole undertaking; not only are there formidable conceptual problems, but there is an almost complete dearth of series which run through the period. We have therefore, been forced into selecting series which may perhaps be continuously available in future, and filling in impressionistic "corresponding" figures for the earlier years after discussion with knowledgeable people.

Entertainment and Sport

The indicators here are all series used for the National Income White Paper estimates of consumer expenditure at 1948 prices; we have included betting in this sector rather than in miscellaneous.

Catering, Hotels and Domestic Service

The indicators here, too, are the consumer expenditure figures. In case the title should be misleading, I ought perhaps to say that the sale of alcoholic beverages carries the biggest weight. We have to include off-licence sales here rather than in distribution, because a single indicator covers off- and on-licence trade; for convenience of computation we also included here the wholesaling of alcoholic beverages. The scope is also wider than that of the Standard Industrial Classification on the catering side, since the indicator for catering services is the volume of food used to produce meals outside the home.

Miscellaneous Services

The main series here are laundries, dry cleaning, hairdressing, chimney sweeping and window cleaning—all done on the consumer expenditure estimates—and undertaking, represented by the number of deaths.

PART IV.—SOME COMMENTS ON THE RESULTS

IV.1. *Non-Industrial Output*

So far I have been discussing the methods by which we have arrived at index-numbers showing the year-to-year movements in the real product of the United Kingdom, which are given in Tables 1 and 2. A discussion of these figures would provide adequate material for a paper in itself, and I am therefore going to do no more than say that the index for the whole economy naturally shows a very much smaller rise than that for industrial production (from 93 in 1946 to 105 in 1949). Indeed, if we take the field outside the scope of the official index as a whole, the level of output was virtually unchanged from 1946 to 1948, with a small rise of about 3 per cent. in 1949. This stability is, of course, largely a result of the fall in Government output, but even if that sector is eliminated the index for the remainder only rise from 91 in 1946 to 103 in 1949.

For the remainder of my paper I wish to sketch some of the ways in which these statistics can be developed.

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IV.2. *Production and Income*

Let me start by reminding Fellows of just what the figures represent, remembering that they relate to a single country which has complex dealings with the rest of the world. This is visualised most easily if we turn to Table 3, in which I have taken approximate figures in millions of pounds for the base year (1948) and applied the index-numbers to them. The resulting series of figures represents the value at 1948 prices (net of all taxes and subsidies) of the net output of goods and services produced "in the United Kingdom" (the United Kingdom being defined in the way explained in section II.3). The output is "net" in two senses, both important. Firstly, it is net of depreciation; and secondly, it is net of goods and services purchased from other countries for use in British output. In other words, it includes exports, but does not include imports, even if they have been embodied in a "British" product: it represents the "U.K. element" in all goods and services supplied either to Britons or to foreigners.

This leads to two very important corollaries, if we are concerned with what happens to the *inhabitants* of this country rather than with what happens *in* this country. Firstly, we must make allowance in each year for transfer incomes in both directions—not only interest and dividends, but also the earnings of Irish labourers helping with the British harvest and British ballet dancers performing in New York. Secondly, if we are concerned with the real value of what is available to Britons—their real *income*,* rather than their real *output*—then we must allow for changes in the terms of trade.

This last point will bear a little further elaboration. We have estimated the value of the U.K. production of goods and services at 1948 prices. In each year part of that total is exchanged with foreigners for an equal value of imports *measured at current prices*; when we value those imports at 1948 prices the equality will usually disappear. We have here a very important illustration of the fact, mentioned in section II.1 above, that our main index measures changes in the volume of goods and services produced, but takes no heed of changes in the amount of "welfare" produced by a unit of output. The volume of goods and services *earned* by means of the country's output can move differently from the volume *produced*.

IV.3. "*Regrettable Necessities*"

The two adjustments mentioned in the last section lead us to rough estimates of movements in the real national income at factor cost. Further analysis should logically start from the other side of the account—the ways in which that income is disposed of, rather than the ways in which it arose (which was our approach). I want, however, to trespass into that field to deal with one point, if only because it featured very largely in our own discussions of the meaning of such things as the "output" of the Armed Forces, and whether it should be included at all. As so often happens, we were approaching the problem from the wrong end, and wasted much time in consequence; once it is found the solution is obvious, but it yields interesting results.

Briefly, then, part of the national income is used for purposes which may be loosely called "regrettable necessities," such as maintaining and equipping Armed Forces, rather than for purposes which contribute directly to positive welfare. There is no logical way of defining the boundaries of what shall be classed as regrettable necessities—if one once allows one's ingenuity free rein almost all the uses of income can be put into that category. But a dogmatic refusal to tackle the problem at all for that reason seems to be carrying purism too far and hiding up important results.

We therefore drew up a list of items of Government expenditure which we felt would be classed by almost everybody as regrettable necessities, roughly corresponding to expenditure directly attributable to the King's enemies (in a wide sense), plus expenditure on collection of rates and taxes. The list is in no sense exhaustive, and we do not wish to imply that no regrettable necessities are to be found in the sphere of private expenditure; but we have probably covered the majority of "clear cases" on which expenditure fluctuates at all greatly.

The measurement of the expenditure on these items at 1948 prices is only approximate, but in some important cases (e.g. the pay of the Armed Forces) the same figure has appeared in the output calculation. We allowed sales of surplus war stores to count as an offset.

* Measured at factor cost.

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The results are shown in Table 4 ; the residue left after the deduction of regrettable necessities naturally shows a much sharper rise between 1946 and later years than the total. The increase in our ability to do the things which we "really" wanted to do between 1946 and 1947 owed more to the reduced claims of regrettable necessities than to the rise in our income.

IV.4. *Productivity*

Finally, a brief word on productivity, if only to ensure that the first statements about it on the basis of these figures are made with due caution.

I do not intend to recount here the numerous and formidable objections to statements about changes in "over-all productivity" based on comparisons between an index of output and numbers employed. I do want to stress, however, the point that a shift of workers from industries with a low value of net output per head to those with a high one will raise the production index without any change in output per head in any single industry. This has been extremely important in the period 1946–1949, because of the decline in the size of the Armed Forces; and it must be emphasized that the low value of output per head recorded for the Forces has no "fundamental" significance, but owes its origin to our methods of accounting (which allow, for example, no interest on the capital equipment used by the troops, nor rent for their barracks and training grounds).

These words of warning are emphasized by giving in Table 5 two sets of index-numbers for output and numbers employed, one including the Armed Forces and one excluding them. The second shows output as rising appreciably faster than numbers employed from 1947 onwards; between 1946 and 1947, on the other hand, numbers had apparently risen slightly faster than output, even though the former exclude those unemployed as a result of the fuel crisis. However, the margin of error in both series is too great for us to attach any importance to the difference in the movements between 1946 and 1947, and not much importance should be attached to the numerical size of the differences for 1947/48 or 1948/49.

The set of figures including the Armed Forces is only given to serve as an awful warning of how the apparent gain in "productivity" may be stretched when we cover a non-homogeneous field and there has been a big redistribution of labour.

IV.5. *Acknowledgments*

I said at the outset that this paper represents the results of a joint project carried on with Mr. C. F. Carter and Mr. Richard Stone. I also owe a great debt to Mr. W. T. Osborn and Mr. A. A. Adams, who have worked unflaggingly with Mr. Carter on the immense amount of detailed work needed in handling the data, and to the computing staff of the Department of Applied Economics, Cambridge, for the speed and accuracy with which the final mass of calculations was performed. Last, but by no means least, we all join in expressing our very sincere thanks to all those people, both inside the Government service and outside it, who supplied us so cheerfully with most valuable unpublished information, without which we could have done little.

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TABLE 1

The Real Product of the United Kingdom

(Index numbers of net output at 1948 prices, 1948 = 100)

Type of activity	*Weight*	1946	1947	1948	1949 (*preliminary*)
Agriculture and Related Activities, Forestry, Fishing, Whaling	58	90	91	100	105
Mining and Quarrying	40	91	95	100	103
Manufacturing (including finished munitions)	390	86	91	100	107
Building and Civil Engineering	73	88	93	100	112
Gas, Electricity and Water	20	92	94	100	104
Transport and Communication	93	91	95	100	103
Distribution and Storage	105	90	97	100	105
Insurance, Banking and Finance	28	94	102	100	(102)
Real Estate (including house ownership)	32	95	98	100	102
Central and Local Government:					
Armed Forces	34	213	135	100	95
Miscellaneous Services	26	90	96	100	104
Professional Services	50	93	98	100	(103)
Entertainment and Sport	12	102	102	100	95
Catering and Domestic Service	36	93	98	100	99
Other Services	13	84	92	100	100
Less Unallocated input of Banking Services*	−10	81	103	100	108
Total	1,000	93	95	100	105

Notes.

(*a*) All the figures given in this paper are provisional and liable to revision. Those put into brackets for 1949 are based on a seriously reduced number of series.

(*b*) Although the classification of activities follows the general pattern of the Standard Industrial Classification, the definitions differ in important respects, for reasons explained in Section III.1 of the text.

* The reason for this item is explained in the footnote in Section III.3.

TABLE 1A

Condensed Version of Table 1

Type of activity	*Weight*	*Index numbers* 1946	1947	1948	1949
Physical production	575	87	92	100	107
Armed Forces and miscellaneous Government services	60	159	118	100	99
Other services	355	92	97	100	103
Total output	1,000	93	95	100	105

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TABLE 2

*Details of the Index for Manufacturing**

*Type of manufacturing**	*Weight*	1946	1947	1948	1949 (*preliminary*)
Textiles	35	80	85	100	106
Clothing and leather	25	90	96	100	106
Metal production*	26	87	91	100	104
Shipbuilding and repairing*	14	101	97	100	99
Motors, cycles and aircraft*	27	86	98	100	119
Industrial Machinery and Equipment	65	63	80	100	108
Other Metal-using Trades*	50	93	100	100	101
Food, Drink and Tobacco	44	95	97	100	104
Chemicals and Allied Trades*	31	85	87	100	110
Building Materials and Furniture	24	84	89	100	109
Paper and Printing	22	90	96	100	117
Sundry Trades	16	72	82	100	103
Munitions*	11	(147)	93	100	108
Total	390	86	91	100	107

* The analysis follows the general lines of the Monthly Index of the London and Cambridge Economic Service; "munitions" production (including naval shipbuilding) is excluded from the ordinary groups and shown separately as a very uncertain series at the bottom.

TABLE 3

Real National Income at Factor Cost. Value at 1948 Prices (£mn.)

	1946	1947	1948	1949
Output of the U.K.*]	8,800	9,000	9,473	9,950
Adjustment for the Terms of Trade†	+ 96	+ 11	0	0
Income from Abroad (net)‡	71	64	55	49
Real National Income at Factor Cost	8,967	9,075	9,528	9,999

* The output figures are derived by applying the Index of the Real Product of the U.K. to the 1948 figure from the White Paper on National Income and Expenditure of gross national product at factor cost *less* provision for depreciation.

This only approximately corresponds to the definition used in this paper, for it includes the profits of oil and insurance companies that originate from activities overseas.

† This adjustment is the difference between the value of U.K. exports at 1948 prices and the import-equivalent of this value, taking account of changes in the terms of trade.

‡ These are the figures given in the White Paper on National Income and Expenditure, adjusted for changes in the average value index for total imports. It excludes the profits of oil and insurance companies operating abroad, which should be included for this purpose.

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TABLE 4

Effect of Regrettable Necessities

	1946	1947	1948	1949
	Value at 1948 prices (£mn.)			
Real National Income at Factor Cost	8,967	9,075	9,528	9,999
Expenditure on Regrettable Necessities*	2,000	1,000	775	850
Residue available for other purposes	6,967	8,075	8,753	9,149
	Index numbers (1948 = 100)			
Real National Income at Factor Cost	94	95	100	105
Residue	80	92	100	104

* Total Government expenditure in connection with the services of the Armed Forces, Ministry of Supply (except civil work and research work done by the Ministry), Foreign Office (German Section), Police, Inland Revenue, Customs and Excise, and other minor items, after deducting both receipts appropriated in aid, and extra receipts paid separately to the Exchequer. Rough adjustments have been made for changes in pay-scales and prices.

TABLE 5

Index Numbers of Output and Numbers Employed

	*Including Armed Forces**		*Excluding Armed Forces*	
	Output	*Numbers in employment‡*	*Output‡*	*Numbers in employment†*
1946	93	97·5	89	90·5
1947	95	98·7	94	96·3
1948	100	100	100	100
1949	105	100·7	105	101·0

* No conclusions should be drawn from a comparison between the movements in the two series "Including Armed Forces." The reason for their inclusion is explained in Section IV.4.

† Total working population in June each year, adjusted for average unemployment and average numbers on release leave not yet in employment. The adjustment for numbers in the Armed Forces is the total in H.M. Forces and Women's Services at June each year (monthly average in 1946). The comparison of 1948 and 1949 is on the new basis of the Ministry of Labour's published figures; the earlier comparisons are on the old basis.

‡ Excludes the pay of the Armed Forces, but not that of the civilians provided for in the Service Departments.

DISCUSSION ON MR. REDDAWAY'S PAPER

Mr. J. L. NICHOLSON, in proposing the vote of thanks:

I should like to offer Mr. Reddaway rather more than just a formal vote of thanks for his paper, because I personally have found it most stimulating and instructive, and I admire, in particular, the freshness of his treatment of old and new problems alike. There is perhaps no one who is better able than Mr. Reddaway to combine a clear theoretical analysis with a shrewd awareness of practical requirements; and these are precisely the qualities needed for tackling a problem that is essentially one of trying to marry what is theoretically desirable to what is practically possible. Since the paper represents the combined effort of a very talented group of men working at Cambridge, it is most unlikely that someone who is shut up in a Government Department and unable to enjoy the freedom of academic discussion would be able to add anything further to the subject. There are, however, a few questions on which I would ask Mr. Reddaway to give us further instruction, and which he did not have space to deal with in his paper.

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First, it was surprising to learn that he found it easier in practice to use the concept of total output net of depreciation, rather than gross of depreciation. The ordinary source of information about base year weights is, of course, a census of production. The results of the 1948 census are only just beginning to come out, and some years will elapse before we have the results of a census of distribution. Mr. Reddaway and his colleagues had to rely on other, and inevitably less reliable, sources of information which more readily yielded figures of net output. They were probably right to go ahead and not to wait for the results of a census of production. But later on, when we have the results, it will obviously be easier to work with the concept of total output gross of depreciation.

Mr. Reddaway assumes, as he is obliged to do, that "true" depreciation in any year is proportional to total output. It is worth considering what this involves. True depreciation may, as a first approximation, be regarded as a function of

(1) the total stock of capital, and
(2) the average degree of utilization of capital.

If (2) is constant, (1) must increase proportionately to total output and his assumption is plausible. If (1) is constant, an increase in output must be accompanied by an increase in (2). His assumption is then plausible only (I should guess) when industry is working near the limit of capacity. If output is well under the limit, the increase in "true" depreciation would probably be exaggerated and the increase in net output slightly underestimated.

From the present point of view it is perhaps a pity that the results of the 1948 Census, so far presented, are based on the old definition of net output. This definition excludes the cost of materials, fuel and work given out, but does not exclude the costs of services (advertising, insurance, banking) which properly belong to the net output of other industries. It is a hybrid concept, somewhere between the grossest possible sense of gross output and the sense of net output which excludes double counting but is gross of depreciation.

On the choice of units, there are one or two cases where I would feel inclined to choose a different method. An interesting case is that of fire insurance on houses. It seems correct to regard the customer as buying "cover for his house." But it is suggested that, in order to allow for differences in the values of the houses and in the risk factor, different houses should be weighted by the premia payable in the base year. The size of the premium is, however, mainly determined by the cost of repairing or rebuilding the house; work which belongs to the output of the building industry, not to that of the insurance industry. The work done by the insurance industry is, I imagine, almost unaffected by the size of the house.

Doctors are another tricky problem. Mr. Reddaway argues that the output of doctors under the National Health Scheme (nothing is said about private doctors) should, on the insurance principle, be measured by something approximating to the number of potential patients effectively covered. He appeals to the criterion of the market contract. It is very useful to have some objective criterion and the market contract may be the best one. But since, in this case, the contract is imaginary, we can only guess what its terms are. In an epidemic, the output of doctors on his method would fall, because of the reduced quality of service, even though they perform much more work. I would prefer a measure which showed an increase in output in such circumstances; a measure relating to something physical or tangible, such as the number of visits, or the number of patients treated. The unwritten contract might, for instance, be interpreted as a contract to supply the amount of services that are necessary, in the opinion of the doctors, in any given circumstances. This would be comparable to the treatment of the armed forces, where the Government is allowed to decide on the strength of the forces necessary at any given time. Or if you take the analogy of fire insurance, the Government collects the money and manages the Health Scheme—work comparable to that of the insurance company in arranging the policy and collecting the premia; while the work of the doctor in repairing the patient's health may be compared to that of the builder who repairs the house.

Another case is that of the season ticket holder who buys the right to travel between (say) Piccadilly and Leicester Square as often as he chooses. The indicator which Mr. Reddaway uses is the number of passenger miles, which is not strictly consistent with the criterion of the market contract. But this is a small point.

There is another point on which I am unable to agree with the Cambridge triumvirate. For a large section of industry (mining and manufacturing) they use the London and Cambridge index of production. This lands them in a difficulty; their index excludes the production of finished munitions for which they have no real information and have to rely on guesswork. There is another and really much better index which includes finished munitions and therefore avoids this difficulty. No one has seriously challenged the official index of production which is based

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on a large number of series and incorporates (e.g. for the building industry) elaborate calculations which make very full use of existing information.

Most of the work in this paper is directed to measuring the real national product, valued at factor cost. But in a brief section at the end an attempt is made to translate this into real national income, in the welfare sense. To make a proper estimate of the real national income in this sense one should really do the whole calculation afresh, and (following Professor Hicks) the valuation should be based throughout on market prices, not factor cost. In practice this would be done by deflating separately each item in the total national expenditure. The result would not necessarily be the same as that obtained by the method given in the paper (Table 3), where national output is simply adjusted for changes in the terms of trade, with an addition for income from abroad.

I would, however, like to repeat that I am most grateful to Mr. Reddaway for his paper, and have no doubt he will be able to answer the points that I have raised. I also hope that in due course we shall be provided with fuller details of this very interesting and enterprising piece of work.

Mr. N. KALDOR: I should like to second the vote of thanks to Mr. Reddaway and his collaborators for an excellent piece of work on the importance of which we are, I think, all agreed. The absence of estimates in any detail of the national income of the United Kingdom from the output side (as distinct from the income side) has been one of the most important gaps in our body of statistics. I felt that keenly when in the last two years I was engaged in Geneva in making all kinds of comparisons between the performance of different European countries, and found that while for most continental countries national income data were available from the output side, for this country and some others they were only available from the income side. I will not go into the reasons for that. The kind of output calculation which has now been done can be done on similar lines in many other countries, including those which lack any reliable data on personal incomes. Our past concentration on estimates from the income side was due to better sources of data on personal earnings, rather than to a comparative lack of basic data on production. I venture to think, however, that in the future, calculations of the national output, when they are more developed than they are now, will prove more useful in many ways than our present body of annual estimates on the national income. I hope, therefore, that this paper is the beginning of larger and more detailed studies in this field; in particular, that it will be possible, as more information becomes available, to give a pre-war link to the estimates; to make retrospective calculations of the national output for pre-war years; and finally that some day it will be possible to construct for this country a matrix of the Leontieff type which will give detailed output and input figures for each industry, thus showing how the output of each particular industry is related to the input of other industries.

I also think it would be highly desirable to link, despite all the warnings which Mr. Reddaway has uttered, output and employment series more closely, and not just on the kind of overall basis as was done in the paper. I fear that the method of functional division which has been adopted by statistical necessity would make it difficult to find individual output and employment series that correspond closely to each other. I expect, however, that with the new census of production and the projected census of distribution, it will be possible to put these estimates on a firmer and more comparable basis.

The authors have brought great theoretical and statistical competence to their task; I do not feel competent to go into the details of the calculation, but I feel, speaking generally, that their method of weighting, which consists, as I understand it, of estimating the value of the net output of individual industries in 1948 by the wage and salary bill and adding to it a percentage for profits based, in many cases, on American information, is a very approximate way of giving an indication of the net outputs of individual industries. However, I am also inclined to agree with Mr. Reddaway that if the aggregate is broken down into a large number of units the problem of weights is not likely to lead to very great error, as the errors will tend to cancel out.

I am not so sure how far the indicators of year-to-year movement will prove to have been reliable when we have the results of a succession of censuses of production for comparison: and I am very doubtful whether ignoring year-to-year input changes, as distinct from output changes, may not introduce a significant difference to the results. Assuming, as Mr. Reddaway has done, that input moves proportionately with output, implies the assumption that all the changes in productivity that occur in a particular industry relate only to the factors of production employed by that industry, and not to the intermediary products which that industry purchases from others. A rise in productivity, however, is not likely to be confined to labour; it may extend to fuel and raw materials. Also, when the relative prices of input and output units change, indices of the

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Laspeyre type may give very different results from indices of the Paasche type; the one needs to be supplemented by the other.

These are not criticisms of what Mr. Reddaway has done; I merely wished to indicate the possible troubles that may arise with the method which he necessarily had to follow, given the material available. I should like to close by saying a few words on the more general and theoretical aspects of the problem, particularly on the meaning of the "real product," the subject matter of this investigation.

I think Mr. Reddaway has made a basic distinction of changes in production and changes in what we may call the capacity of production to create welfare. What he was attempting to measure is the change in output irrespective of changes in the capacity of that output to satisfy needs. That is to say, he made a distinction between the means and the ends, and this is a measure of the means available to satisfy the ends without any regard for changes in wants and the consequent changes in the want-satisfying power of commodities. I am fully in agreement with that; the question is whether this distinction can be quite so sharply drawn as he has drawn it.

Again, I think Mr. Reddaway is well aware of the problem. His remarks earlier have indicated that when we come to changes in quality we are up against not only questions of statistical measurement, but against the theoretical problem of what constitutes a change in quality and what does not. An answer to this could only be gained by an appeal to utility; it could not be settled by reference to the nature of the contract, or a reference to what happens in the market place. Perhaps I may make a little more clear what I have in mind. If you take, for example, distributive services, what is the real output of distributive services? One way of defining this is simply the amount of goods distributed—the real output of distribution moving *pari passu* with the amount of goods passing through it, and that is a method which Mr. Reddaway in the circumstances rightly followed. On the other hand, some people may contend that the output of distribution can go up in relation to the amount of goods distributed, when, e.g. the distributor provides more services than he has provided in the initial period. It is often suggested that real output of distributive services in this country during the inter-war period expanded considerably in relation to the amount of goods distributed.

When the number of people engaged in distribution expands relatively to the amount of goods distributed, we could say, on the one side, that there was a fall in productivity—whereas the job was done before by x men, now it is done by so many more; or we could say that the output of distributive services has expanded in relation to the output of commodities. When the distributive margins in selling, say, motor cars, go up, so do the amount of services provided by the distributor. There is something in this, but it is impossible to measure what it is. The consumer clearly gains something in utility, but since there is no separate price, the appeal to "the market place" and to what is implied in the contract breaks down as a test of value. When a consumer buys a motor car, he buys with it a whole bundle of services, the contents of which are not separately priced, such as free inspection, free rides, free advertisement, free this, that and the other. Clearly he has got something, but since he has no choice but to buy the whole bundle, it is not possible to measure their additional value—as would be the case if he were free to refuse these services, by buying the car at the manufacturers' price and buying the other services separately if he wished to have them.

Between the two extremes of either taking the number of goods distributed or the number of people engaged in distribution as the measure of the real output of distribution—similarly to the procedure that had to be followed in the case of the Armed Forces, for example—there is no middle way, and I do not see that there is in principle any solution to this problem. In the same way I do not see that there is any clear principle to determine what constitutes the real output of medical services. Mr. Reddaway's method was that the output of medical services changes with the number of patients covered. But if there were more doctors available in relation to patients the quality of the service would undoubtedly improve—at any rate up to a point—a far more genuine improvement in quality than in the case of the distributive services attached to motor cars. Making no allowance for this undoubtedly underestimates therefore the change in the national product over a period.

I should like to say again that I think Mr. Reddaway and his collaborators have done an admirable job which I hope will be the beginning of a larger and more detailed work in this field.

Professor ALLEN said that he was very happy to join with the proposer and seconder in expressing indebtedness to Mr. Reddaway; undoubtedly Mr. Reddaway had presented a piece of work which was not only important in itself, but was very stimulating for further work and discussion. The proposer and seconder had covered a good deal of ground in their comments, but he proposed to comment on one particular point, a basic one of general principle, referred to on p. 436 as the Geary formula.

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Mr. Reddaway said that he was using "net output" in what the speaker would regard as the proper form, gross output presumably including work in progress, minus all inputs, including materials and fuel, but also outside services (advertising and so on). He said that this net output figure was lower than that usually defined for purposes of a Census of Production. It was useful to have a term to distinguish between Mr. Reddaway's concept and that of a Census of Production, and he would like to use the term "census value added" for the larger figure, that is, output minus materials and fuel only. While he was on this point he would say that he had seen some figures for manufacturing industry which compared the figures of net output and of census value added, and the differences were quite considerable. The relative values were quite different, and the effect of using the two forms of weights in an index of manufacturing production was to give significantly different figures for the index.

The Geary formula which Mr. Reddaway introduced in point (*c*) and took up in the following paragraph could be amplified a little. The essence of the formula was the extension in real terms of the net output figure and the formula which Geary proposed was the difference between two things, one being gross output at constant base prices (of outputs) and the other input at constant base prices (of inputs). Changes in work in progress were to be included in gross output and all outside services in input. The Geary formula was only an approximation of what was really needed which was net output itself in real terms, that is, net output valued at the proper price which would be price margins per unit of work done or something like that. The Geary formula approximates to that by taking gross output at constant prices of outputs and input at constant prices of inputs.

If one was thinking of production of cotton cloth, what was needed was the net output of the industry producing cotton cloth from raw cotton and net output in real terms would involve a constant price margin between raw cotton and cloth. The Geary formula took a constant price per unit of cloth on the one hand, and on the other inputs at constant prices per units of input, that is, raw cotton price per lb., coal price per ton, and so on. This was only an approximation; it did not follow if the price of cloth, of raw cotton, of coal, and so on, all remained constant, the price margin was constant. That relation was not necessary, and it needed to be examined. The Geary formula involved certain assumptions in addition to those made in using indicators to approximate to gross output and input. He stressed this point, not because he thought Mr. Reddaway would disagree, but because he wanted to stress that there was a complicated set of assumptions lying behind his use of the indicators. Like Mr. Kaldor, who made much the same point, he would not disagree with Mr. Reddaway's practical method, but he would emphasize the need for further experimentation when data existed of a suitable kind for testing the Geary formula and the various approximations involved. It was clearly important that the validity of the formula should be tested. Some work was going on in the Dominion Bureau of Statistics at Ottawa and the more that could be done the better. Meanwhile he would not object to Mr. Reddaway's methods, but merely point out that the assumptions involved were a formidable set.

The point about depreciation had been adequately covered by the proposer of the vote of thanks. On the whole, he tended to agree with Mr. Nicholson. Having considered the problem in very much the same way as Mr. Reddaway, he decided it would be better, from census material, to obtain net output gross of depreciation and not net of depreciation.

Dr. E. Stern, after expressing his appreciation of this excellent paper, asked for further clarification on the question of the treatment of depreciation of houses. Had the depreciation been treated as an equal percentage, a necessarily arbitrary percentage, or as equal to the houses replaced every year, assuming that the replacement was very largely due to obsolescence. Secondly, how had expenditure in the administration of justice been treated? Was it deducted as an input of industry and trade? Thirdly, how had the expenditure on the assessment and collection of taxes been treated—as output of Government and deducted as input of industry?

Mr. A. P. Zentler expressed his admiration for the paper—not least for the author's simple, logical style; unlike so many severely technical papers it was a pleasure to read it. What he had to say was not in any way a criticism; he wished to make one or two suggestions which the author might consider worth pursuing. Firstly, he thought that to some extent the index numbers of net output given in the paper assumed away the difficulties. Whilst the concept of "total output *net* of depreciation" might well be a more valuable one to study than total *gross* output, the index numbers given in the paper were really half-way houses between net and gross output. They would only show movements in net output if the broad assumptions made were correct. In connection with this, two suggestions might be made: (*a*) it would be interesting to see what the movements in *gross* output looked like, provided it was not too difficult to estimate the base

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year *gross* outputs—at least for the main sub-divisions—and, (*b*) it would be desirable to investigate in as many cases as possible the correctness of the assumption made about inputs. The latter was particularly important when one considered single industries, as various people would doubtless do. He noticed that the author had, in fact, attempted to measure inputs for the building industry, but almost certainly there were other interesting cases. If too much work were involved, the author might at least try to find the "soft spots" in a detailed list of industries; this would indicate to other research workers what fields were particularly promising for further work and would also prevent users from mis-using the index numbers.

Lastly, in a paper of this kind one would have hoped for a thorough discussion of the concept and measurement of "true" depreciation. He happened to have talked recently about some of these problems with officials of the B.E.A. and B.T.C. in connection with work he was doing on comparisons of capital investment, and could only say he was horrified to see how little the sweeping generalizations economists tended to make fitted in with what happened in practice in these two fairly large sectors of the economy.

The paper was singularly uninspired in its treatment of "changes in quality." Several years ago an attempt was made in the United States—in connection with a study of the demand for motor cars—to measure changes in quality by multiple regression methods. Whilst the method, even at its best, has obvious limitations in its application to the whole range of industrial products, it might well be suitable in a few important instances, such as cars, houses, various types of capital equipment, etc. In any case, it was high time some more refined methods were devised to solve this problem of quality changes. If eminent economist-statisticians like the contributors to this paper would not do it, he much doubted if anyone would.

Dr. Oswald George said he would like to join in the chorus of praise for the paper. It would be specially appreciated by those who knew from experience some of the many difficulties which the author had had to face and had overcome. It had been appreciated so much in his Department that he had been unable to get his copy back from the many borrowers until late the previous evening. And all statisticians would appreciate the author's particularly happy phrase "eclectic opportunism" which might enable them to describe statistical methods which hitherto they may have regarded as indescribable.

Some of the points he might have raised had already been dealt with by previous speakers, and the few comments he would make would necessarily be scrappy. In so far as they had any connecting link, it would be the difficulties arising from changes in circumstances, internal and external. Firstly, on the question of principle, the author, while realizing that "true" depreciation is notoriously a difficult thing to measure, suggested that one might plausibly assume that it moved approximately with output. But one might wonder how far this would be true in certain cases, especially during transitional periods, and how far it would affect the validity of the author's results.

The author suggested that in making judgments about welfare, any changes in "needs" must be allowed for on the other side of the account; if in a very cold winter we need more fuel—which is obtained by overtime—to keep us at the old temperature, then, if there is no reduction in other output, the index will rise. But it is interesting to note that this will presumably be true only so far as the fuel is not bought by employers to keep employees warm.

Another point was that of insurance. Here the author argued that if the fire risk permanently increases and premiums are raised, the householder buys not more insurance but more expensive insurance. If this be an accepted principle, one may wonder why it should not be extended to such "regrettable necessities" as expenditure on the defence services which might be regarded as insurance for the safety of the realm, with all the complications mentioned, including increased insurance premiums, plus those of "under-insurance."

The treatment of tax collectors suggests the possibility that the introduction of a new public service with a new special tax to finance it might increase the index two-fold—through the "output" of civil servants in both the activities. And one may wonder why official tax collectors produce "output" and clerks employed by firms on P.A.Y.E. accounting do not.

There were a few other points which at that late hour he would defer in the hope that he would be able to discuss them with the author after the meeting.

Mr. J. C. Westoby feared that the interest of the wider public might be concentrated on the details of the analysis in Table 1 rather than on the methods which the author had employed. He thought it could not be sufficiently emphasized that it was precisely these details which were most subject to error as a result of the expedients forced upon the author by the nature of the data available; in particular, the assumption that net to gross ratios remained constant and the

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artificial definition of industries. He simply wanted to draw attention to the fact that, though the method employed might lead to aggregate figures in Table I which were acceptable, the detailed analysis by industry gave a picture by no means reliable.

He thought that Mr. Nicholson's complaint that net output, as published in the preliminary reports on the 1948 Census of Production, was incorrectly defined, should not pass without comment. Clearly the definition adopted was designed to facilitate comparison with past and future years. The final reports would include additional data on various costs not hitherto the subject of Census enquiry, and it was open to any user of the statistics to make such deductions from the published figures of net output as suited his purpose.

Dr. ROSTAS said that his comment referred to the point raised by Professor Allen, namely, the principle of estimating the net output of each industry by revaluing the output and input of any year at base year prices. He thought that a better approximation to net output would be to use double weights, i.e. revaluing both output and input at base year as well as current year prices. This was a procedure which was used, incidentally, by Mr. Geary. Conceptually, this might not be too tidy, but in practice it would give nevertheless a better approximation than using either base year prices only or following the procedure proposed by Professor Allen. He felt that using base year prices of both input and output might put too great a reliance not only on the appropriateness of the relative prices of finished goods, but also on the appropriateness of the prices of materials relative to the prices of finished goods. Such a procedure might give queer results in respect of individual industries, although he admitted that their effect for industry as a whole was much less significant.

The following written contribution was received after the meeting:

Mr. DUDLEY SEERS: There is only one point of detail I would query in Mr. Reddaway's most valuable paper. He is rather over-simplifying the problem of government service to industry. Including the agricultural advisory service, for example, as part of the agricultural industry involves the tacit assumption that the whole of the year's 'advice' directly affects the year's agricultural output (an assumption which comes out more clearly in his earlier paper). Surely the effect of the service is much more long-term, and in view of the time-lag between changes in productive technique and the resultant changes in output, one would expect the advice to have almost no effect during the year in which it was given. Thus to count the increases in 'advice' *and* in agricultural output involves little "double counting." It would seem more reasonable to treat educational services of this sort analogously to general education, i.e. as a final product, rather than as an "input" item.

The other service cited, that of the employment exchange, does much more than increase the level of output, since it affects directly the contentment of those who would otherwise be without employment or in less satisfactory employment. Moreover, currently it has a most important function of trying to make the structure of employment more useful in our present difficulties.* On these grounds there is surely a strong case for considering it a "final" service in its own right.

Underlying Mr. Reddaway's treatment of this section, and also his decision to make a reduction for "regrettable necessities," lies the great heresy of the More Significant Aggregate. Some of the national output as conventionally defined is presumed to be an "intermediate product," in Professor Kuznets's language, undertaken in order to make possible the remainder, which is intrinsically valuable. Any dividing line is bound to be unsatisfactory, as the author admits. His classification involves treating the slowness of demobilization in 1946 and 1947 as a "necessity" and any increase in the police forces as "regrettable." Its disadvantage is that it tends to suggest that the "regrettable necessities" are dictated by the situation, while the maximization of the "residue" is a suitable object of policy. In actual fact, to use increments in the product, for example, to increase military spending or police forces or inland revenue staff or consumers' goods are alternative possibilities of helping the attainment of almost any long-period objective such as political security or economic welfare. Whether a rise in the "residue" due to a reduction in "regrettable necessities" is a matter for congratulation depends on the circumstances, and the meaning of such a rise is therefore subject to much more cautious interpretation than a change in the original aggregate "Real National Income." It is in these complex days dangerous to think merely in terms of maximizing the output available for the consumer *now* (consumption, social services) or *later* (capital investment). There is something curiously nineteenth century in the materialistic search for a More Significant Aggregate.

* The advisory service to agriculture also has similar qualitative functions.

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Mr. REDDAWAY thanked all those who had contributed to the discussion, and said that he would reply to most of the points in the *Journal*. He had, however, been struck by the way the discussion had largely focused on depreciation, and on that point he thought Fellows might like to know the inner history. Originally the team had intended to avoid the problem by measuring movements in *gross* national product, and his earlier paper had related to that. Later, when the problem of computing weights was being considered, it seemed as if the easiest way to find them would be by adding wages, salaries and profits, and that the easiest profit figures to find would be on a "net" basis. Before changing it was then necessary to consider the more important question of indicators: would the indicators serve to measure year-to-year changes in output net of depreciation? Clearly they were likely to be rather more inaccurate on a net basis, since they contained no direct reference to depreciation, but (as Mr. Nicholson had explained) it was not a silly assumption to say that the depreciation would move roughly in proportion to output. As the matter seemed to be almost neutral for indicators and the weights appeared to be easier to find on a net basis, they had decided to change over and do the net product from then onwards. Subsequent work had made them doubtful whether the calculation of weights on a net basis really was any easier, but it was then too late to change back so far as this paper was concerned.

Mr. Nicholson had been doubtful whether the doctor had a contract under the Health Service. He felt unrepentant on that: the contract might not be direct with the individual patient, but the doctor had contracted to look after him when he took him on his panel. In an epidemic it seemed quite natural to say that the doctor was having to work very hard to produce the same output (and the same pay)—just as a turkey-rearer had to work hard if his flock caught an epidemic.

Mr. Nicholson had asked why the team did not use the C.S.O. index for the industrial sector rather than the London and Cambridge one. This showed a misapprehension: they had attempted a fundamentally new calculation, using all the data which were available for an annual index, much of which could not be used in a monthly one, or would involve too much work. In places they had used a subsidiary index of the C.S.O. one, if that seemed to embody the best information, but essentially it was a new computation, using more series than either of the monthly index-numbers.

Finally, he heartily agreed with the critics who asked for more information about the new index. There was one respect in which nobody could doubt that the L.C.E.S. index was vastly superior to the C.S.O. one, and that was in the publication of the details of its construction. He was making no rash promises about giving quite such full particulars for the much larger number of series now used, but he had been much moved by the criticism that the present paper was almost as reticent about its methods as a Government publication, and it was the team's intention to publish a much more detailed account when energy and publisher's priorities permitted.

Mr. REDDAWAY subsequently wrote as follows:

I do not wish to add anything on the subject of depreciation, except that we have reverted to the concept of *gross* national product. The resulting figures are given in an article in the August, 1950, *Bulletin of the London and Cambridge Economic Service;* the effect on the index numbers of the change in weights (which was all that the new definition in fact involved) was virtually negligible.

On Mr. Nicholson's points about units, I quite agree that consistency demands that the transport of season-ticket holders between Piccadilly and Leicester Square should be measured in terms of tickets sold, or "weeks of permitted travel", rather than passenger-miles. I imagine that in fact the number of passenger-miles is estimated as a constant multiple of the number of tickets sold, in which case we had inadvertently been applying the right principle. (The point is rather more important in relation to water supplied to domestic households without a meter.)

I cannot, however, agree with him about the insurance of houses. It may not involve any more physical work for the insurance industry to insure a large house, but the premium is normally proportional to the value, and everybody in the industry will certainly reckon that they have sold more insurance when they have issued a policy for £5,000 than when it is only £1,000. This is one of the cases where the market valuation of two items of output does not conform to one's notions of the relative amount of work done; the point is even clearer where the industry's charge is shown separately as a percentage commission, e.g. with stockbrokers.

Mr. Nicholson quite rightly makes the point that my Table 3 does not show movements in real national income as defined by Professor Hicks. It was never intended, however, to be appropriate for such purposes, and I have inserted the words "at factor cost" to reduce the risk of confusion. Personally I find it useful to have a constant-price series for national income at factor cost, and I am not convinced that market prices are the most logical basis on which to combine personal consumption and (say) Government expenditure, even for welfare purposes.

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I naturally agree with Mr. Kaldor in feeling uneasy about the assumption that the ratio of input to output remains constant; but I think his argument that it rules out the possibility of a rise in productivity extending to fuel and materials is liable to be misleading, since it suggests that the index thereby acquires a downward bias. A rise in productivity may very well be associated with a *higher* ratio of fuel to output as a result of mechanization, which may also lead to a greater proportion of waste materials. The errors are by no means all one way, and personally I have been more frightened of the ratio of input rising as the economy becomes more complex. Like Mr. Zentler, I wish that input were more often measured separately.

On the question of quality I do not feel that the theoretical problem is always so insoluble as Mr. Kaldor suggests, though I am not as optimistic about its being tackled in practice as Mr. Zentler. It is not always the case that in one period there is only one system of selling—one "bundle of services"—and that then there is a sudden change to a different one, with no overlap. There will frequently be some shops providing lavish services at a high margin with others doing a "cheaper" trade; even with motor cars one might in practice find the alternative, either through generous "trade-in" prices, or by comparing the policies of different manufacturers. In principle, therefore, one would often get a rough basis of market valuation, and arguments by analogy would also seem reasonably legitimate.

I must confess that I do not understand Professor Allen's reference to the Geary formula giving only an approximation to "net output itself in real terms." If, in his example, the cotton industry started using different amounts of coal, size and other materials per yard of cloth, how would he portray the result? And what does he do where there is no obvious single material to give some reality to the notion of a price margin, e.g. with house-building or coal-mining?

The answers to Dr. Stern's questions are that houses are treated on the conventional basis used for Schedule A, and that the administration of justice and collection of taxes are treated as final output.

Dr. George raises a very difficult issue with his point about fuel used to heat factories, offices, etc. The conventions of social accounting treat all such things as input items undertaken for the benefit of the business, and disregard any element of "welfare" or "real income" which workers may derive from them. Perhaps Dr. George would like to ask firms to show on their census forms how much of their expenditure on materials and fuel was really for the benefit of the workers.

I quite agree with Dr. Rostas and others who made the point that both output and input should ideally be compared on the basis of current prices as well as those of the base year; I gave an extreme example of the possibly absurd results which might otherwise emerge for a single industry in my earlier paper. For the economy as a whole, however, or even large sectors of it, I doubt whether the difference in the results would often be of much importance.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Frank Dudley Bushell.
Sidney William Caffin.
Robert Brinley Codd.
George Ivan Gale.
Charles John Guy.
James Tegwyn Harris.
Cyril Davenport Hughes.
Thomas Ffowc Hughes.
Hugh Cormack Mackenzie.
Robert John Nicholson.
Bhagavathula Rao.
Andrew Lawrence Wilson.

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The Sources and Nature of Statistical Information in Special Fields of Statistics

Statistics Relating to the U.K. Iron and Steel Industry

By Robert M. Shone

Introduction

1. Regular statistics relating to the iron industry began to be collected in 1839, when the Museum of Practical Geology was enjoined by the Treasury to preserve records of mining operations and to collect statistics of the British mineral industries. Robert Hunt, of the Mining Record Office, accordingly began to collect and publish statistics of pig iron production, to which, later, details of steel production were added. In this the industry co-operated. In 1882 this work was continued by the Mines Department on behalf of the Home Office.

In 1875 the British Iron Trade Association was founded, and began systematic publication of iron and steel statistics in 1878. This work was continued after 1915 by the Iron, Steel and Allied Trades Federation of Middlesbrough, which had been formed in 1906 and took over the work of the Association when it was dissolved in 1915. The Annual Statistical Report of the Federation had sections on U.K. mineral statistics, pig iron production, steel-making, prices, shipbuilding, imports and exports, etc. In addition, there were sections on the Dominions and foreign countries.

In 1918 the National Federation of Iron and Steel Manufacturers took over the functions of the earlier Federation and continued to publish a similar Statistical Report together with additional information on the production of steel by districts, the sources of iron ores smelted in the different districts, coal freights and the prices of pig iron and steel. In 1919 the Mines Department ceased to collect statistics, relying thereafter on those collected by the Federation. In 1920 the Federation's *Monthly Statistical Bulletin* was first issued.

In 1934 the British Iron and Steel Federation was formed and continued to publish annual and monthly figures. The publication of statistics was discontinued during the war and was not resumed until the publication in September, 1945, of statistics for the years 1939–44, which had been collected by the Iron and Steel Control. The issue of the *Monthly Statistical Bulletin* was resumed in January, 1946.

2. The main sources of statistics on the U.K. iron and steel industry are the *Monthly Statistical Bulletins* and the *Statistical Year Books* of the British Iron and Steel Federation. Both publications give figures of ore and sinter production, pig iron production and materials consumed, steel production and materials consumed, semi-finished steel deliveries, finished steel production and deliveries, numbers employed, prices, imports and exports. The *Year Book* gives more information under these headings and also contains information which is not given in the *Monthly Bulletin*, e.g. the consumption of fuels, the number of blast furnaces and steel furnaces in the U.K., details of earnings and hours, receipts, consumption and stocks of scrap and figures of production and materials consumed in respect of cast iron and wrought iron.

Additional information regarding imports and exports, not published in the monthly *Trade and Navigation Accounts*, is included. The index of wholesale prices of the Board of Trade is reproduced, together with the sub-indices for iron and steel and for coal. Figures of employment, unemployment and disputes are given monthly in the *Ministry of Labour Gazette* and twice a year information is there given regarding earnings and hours. The industry was covered by the 1935 Census of Production and also the partial inquiry of 1937,* but was excluded from the partial Census of 1946.

In addition, each *Monthly Bulletin* includes one or two articles dealing with topics of interest to the industry. A list of these is given at the end of this article.

3. There is a large number of firms in the iron and steel industry, but the industry does not embrace the total activities of these firms since some of them are engaged in allied processes which may be regarded as steel-consuming, rather than steel-producing, activities. Statistically speaking,

* Under the Import Duties Act, 1932.

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the industry is to be defined so as to include a specified range for processes. This involves problems at the finishing end, for the line between steel and steel-using industries is not always drawn in the same way. In particular, drop forgings and wire are included in some countries but excluded in others. For these reasons care should be exercised in the use of statistics drawn from different sources since the definition used may not be the same. Comparisons between countries need careful analysis not only because of differences in definition, but because the pattern of finished products and methods of production may differ widely. This may be illustrated by reference to various official definitions.

The U.K. Standard Industrial Classification definition consists of Order V (Metal Manufacture), except for non-ferrous metals, and includes iron smelting, steel-melting and rolling, including sheets, tinplate, tubes and steel castings, i.e. minimum list headings 40, 41, 43 and 44. In addition, the production of iron castings in foundries is included, (minimum list heading 42) except where the foundry is attached to an engineering firm, in which case it is included in the main trade of the parent concern. The production of wrought iron is also included. The definition of the International Standard Industrial Classification is as follows: "Manufacture of iron and steel including all processes from smelting in blast furnaces to the semi-finished stage, that is, the production of billets, blooms, slabs or bars; re-rolling into basic forms such as sheets, plates, strip, tubes, rails, rods; tinplate; rough castings; forgings."*

Unlike the U.K. Classification, it is not clear whether this definition includes wire drawing and drop forgings, whereas these are included in minimum list headings 93 and 92 respectively of Order VIII of the British classification. The I.L.O. Steel Committee definition also includes the drawing of wire, but unlike the others, excludes castings and forgings.† All these definitions agree in excluding iron ore mining and the production of coke in the industry's ovens (although it is common for mines to be owned by iron and steel firms or their subsidiaries and for an industry to produce a large part of its own coke requirements). With these considerations in mind, it is possible to see that the totality of "iron and steel" firms is not synonymous with the industry; many such firms, for example, have large engineering interests.

4. The iron and steel industry is concerned primarily with the smelting of iron ore for making pig iron, the production of crude steel and a wide range of rolled, forged and cast products. The iron ore is charged into a blast furnace, together with coke and limestone, and smelted to produce pig iron. The pig iron may be allowed to cool, so that it can be stored for making steel or sold to other concerns, such as iron foundries, to be used for the production of iron castings. Alternatively, in an integrated works, the molten metal may be stored in a mixer before being fed to the steel furnace in which the iron is transformed into steel.

The following table shows the production of pig iron and crude steel for the years 1920, 1929, 1937, 1948 and 1949. These years have been selected since they were all peak production years:—

TABLE 1

Production of Pig Iron and Crude Steel
(000 *tons*)

Year	*Pig Iron**	*Crude Steel*†
1920	8,035	9,067
1929	7,589	9,636
1937	8,493	12,984
1948	9,276	14,877
1949	9,499	15,553

* Including blast furnace ferro-alloys.
† Steel ingots and steel for castings.

Iron Production

5. Hard coke is used for smelting the iron ore in the blast furnace. The iron and steel industry produces coke in ovens located at the blast furnaces, the by-product gases being utilized to fire

* United Nations, Economic and Social Council Statistical Commission, Supplement No. 5B to Official Records, 3rd Year, Seventh Session, 1948, p. 22.
† I.L.O. Iron and Steel Committee, General Report, p. 68 (1949).

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steel furnaces, etc. In addition, the industry obtains coke from N.C.B. ovens located mainly at the mines.

TABLE 2

Coke—Production by the Iron and Steel Industry, and Consumption in Blast Furnaces
(000 *tons*)

	1948	1949
Coal carbonized in industry's ovens	10,490·0	10,726·2
Output of coke by industry—Coke	7,045·4	7,193·9
Breeze	431·0	455·5
Purchases of coke by industry for blast furnaces and sinter plants—Coke	4,149·1	3,962·8
Breeze	51·4	35·6
Coke consumed in blast furnaces	9,974·3	9,983·4
Coal equivalent of coke consumption in blast furnaces*	14,961·6	14,976·9

* Converted on the basis that 3 tons of coal yield 2 tons of coke. A small quantity of coal consumed as such is also included.

In 1949 some 17 million tons of coking coal was consumed by the industry directly and indirectly, of which about 15 million tons was by blast furnaces. In addition, about 8 million tons of non-coking coal were consumed by the steel furnace gas producers, steam boilers, works locomotives, etc. Thus total coal consumption was some 25 million tons. The consumption of coke is intimately related to the availability of scrap. When the latter is plentiful, proportionately less pig iron is used in steel-making, with a corresponding reduction in coke requirements.

6. The main home ore-fields, which produced almost 13 million tons of ore in 1949, lie in the great Jurassic belt which runs south-west to north-east across Oxfordshire, Northamptonshire, Lincolnshire and Yorkshire. In addition 350,000 tons of hematite (non-phosphoric) ore was mined in Cumberland, together with small quantities of other types elsewhere.

Home ores are "lean," with an average metallic content of approximately 30 per cent. Indeed, smelting is successfully carried out with a self-fluxing mixture of Frodingham ore, having a metallic content of only 22 per cent., with richer home ore, giving an average metallic content of 26 per cent. The use of lean ores naturally involves a higher throughput of material, including coke. This necessitates more handling and preparation facilities per ton of iron produced, the costs of which are, however, offset by the cheapness of the home ore relatively to the richer imported ore. Imported ores have an average metallic content of 55 per cent. and come mainly from Sweden and French North Africa. Small quantities of scrap may be charged to the blast furnaces and this reduces coke requirements. This is a useful way of using scrap which is unsuitable for steel-making. The practice is, however, much more widespread on the continent than in this country.

7. Manganese is an important element in steel-making and 386,000 tons of manganese ore, largely from British West Africa, were consumed by blast furnaces in 1949 to produce ferro-manganese and spiegeleisen (blast furnace ferro-alloys).*

8. At the end of 1937 there were 200 blast furnaces in the U.K., the corresponding figure for 1949 being 140, while the average number in blast for these years was 124·53 and 101·38 respectively, indicating a higher degree of utilization in the latter year. (The number of furnaces in blast is always less than the number in existence, since there are always some furnaces idle for re-lining and repairs.) This was associated with a considerable improvement in output per furnace (from 68,500 to 93,700 tons per annum) due to improved efficiency, the gradual introduction of larger furnaces, and the increased use of richer imported ore. The improvement in the case of furnaces making basic iron was even more marked. As a consequence of these changes, the output of pig iron was 9,498,500 tons in 1949 compared with 8,493,000 tons in 1937 in spite of the smaller number of blast furnaces.†

9. Apart from the fluctuation due to trade cycle influences, production of pig iron over the last 50 years has remained at a broadly similar level; the output of hematite declined relatively

* Spiegeleisen has a manganese content of about 20 per cent.; ferro-manganese has some 80 per cent.
† Eleven blast furnaces were under construction or being rebuilt at the end of 1949.

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TABLE 3A

Sources of Home Ore Consumed in Blast Furnaces and Sinter Plants in 1949†*
(000 *tons*)

District	*West Coast Hematite*	*North Lincs*	*Cleveland*	*South Lincs, Leicester, Northants, Oxford*	*Other Districts*	*Total*
1. Derbyshire, Leicestershire, Notts, Northants and Essex	..	159·9	..	4,632·9	..	4,792·8
2. Lancs (other than 10), Denbighshire, Flintshire and Cheshire	..	70·4	..	376·9	..	447·3
3 and 9. Yorks (including Sheffield other than 5)						
4. Lincolnshire	..	2,506·9	..	1,768·3	..	4,275·2
5. North-East Coast	..	..	884·9	530·6	..	1,415·5
6. Scotland	..	..	..	0·7	..	0·7
7. Staffs, Salop, Worcs, and Warwick	..	..	..	689·3	1·8	691·1
8. South Wales & Monmouthshire	..	..	..	408·3	98·8	507·1
10. North-West Coast	327·7	..	..	..	..	327·7
Total	327·7	2,737·2	884·9	8,407·0	100·6	12,457·4

* Raw and calcined, as charged.
† Hitherto the consumption in blast furnaces and sinter plants has been shown separately.

TABLE 3B

*Sources of Imported Ore Consumed in Blast Furnaces and Sinter Plants in 1949**
(000 *tons*)

District No.	*Iron Ore*								*Manganese Ore*
	Newfoundland	*Sierra Leone*	*France and French North Africa*	*North Spain*	*Spanish Mediterranean and Spanish North Africa*	*Sweden*	*Other Countries*	*Total*	
1	4·0	109·0	87·9	..	192·5	8·4	..	401·8	28·1
2, 3 and 9	19·2	6·5	92·4	0·8	8·1	64·5	..	191·5	138·9
4	..	22·0	95·3	8·6	..	67·3	..	193·2	0·6
5	133·7	261·4	969·9	25·9	230·2	1,181·0	128·6†	2,930·7	168·4
6	184·2	138·2	333·1	21·3	156·0	283·8	11·3	1,127·9	6·4
7	44·0	45·6	106·2	3·9	..	111·3	0·1	311·1	11·1
8	222·0	90·9	529·2	179·8	133·4	535·1	10·2	1,700·6	17·6
10	..	..	349·4	53·6	293·4	302·4	3·4	1,002·2	15·4
Total	607·1	673·6	2,563·4	293·9	1,013·6	2,553·8	153·6	7,859·0	386·5‡

* Hitherto the consumption in blast furnaces and sinter plants has been shown separately.
† Includes unallocated.
‡ Includes British West Africa 191,400 tons, India 64,100 tons, South Africa 79,600 tons and other countries 51,400 tons.

to basic pig iron until by the early twenties they were of comparable importance. During the thirties there was a further shift to the basic quality, a change which has persisted into the post-war period.

Hematite pig iron is used partly for acid steel-making and partly for iron castings. Basic pig iron is used wholly for steel-making.

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TABLE 4

*Production of Pig Iron**
(000 *tons*)

Year	*Hematite*	*Basic*	*Foundry*	*Forge*	*Direct Castings*	*Blast Furnace Ferro-Alloys*	*Total*
1900	3,865·4	925·0	3,866·4		..	302·9	8,959·7
1913	3,604·8	2,529·8	3,801·6		..	324·1	10,260·3
1920	2,941·9	2,661·7	1,549·7	605·0	32·4	244·0	8,034·7
1929	2,347·9	3,196·5	1,511·0	275·2	80·0	178·7	7,589·3
1937	1,865·9	4,689·0	1,607·3	176·4	7·2	147·3	8,493·1
1948	1,366·4	6,255·5	1,395·6	92·8	2·6	163·5	9,276·4
1949	1,437·3	6,248·2	1,555·3	87·4	2·3	168·0	9,498·5

* Includes blast furnace ferro-alloys.

There has been little change in the balance of production between districts compared with pre-war and the North-East Coast remains the largest producer, followed by the Derby, Leicester, Northants district, Lincolnshire and South Wales. The areas show little comparative change with the exception of Scotland, South Wales and Lincolnshire which have recorded some increase.

Pig iron production in 1949 was 9½ million tons, of which two-thirds was used by the producers and the rest despatched to other steelmakers, foundries and wrought iron makers. The changes in the balance of the hot and cold processes, and in the proportion despatched, are shown in Table 5. They have been associated with improvements in operating efficiency.

TABLE 5

Disposal of Pig Iron and Ferro-alloys

	1920 %	1929 %	1937 %	1948 %	1949 %
Used in own works—molten	25	36	45	52	52
cold	15	11	14	14	13
Despatched	60	53	41	34	35
	100	100	100	100	100

10. There are more than 2,000 foundries in the country producing iron castings, many of them in association with engineering firms. These depend on the iron and steel industry for their pig iron. In 1949, 2·3 million tons of pig iron and 2·5 million tons of scrap were consumed in the production of 3·4 million tons of iron castings (pipes, railway chairs, stoves, motor vehicle castings, etc.). Federation statistics divide this production into 50 types of castings, the nature of which gives a good indication of end use.

11. In 1949, 87,400 tons of forge pig iron were produced, of which 54 per cent. was used in the producers' own works, 36 per cent. was despatched, the remainder going into stock. Only 8,800 tons was used in wrought iron works. Finished wrought iron products are made from two semi-finished products: (*a*) puddled bars, made mainly from forge pig iron and cast iron scrap, and (*b*) scrap, ball and bushelling bars, made mainly from wrought iron scrap.

As has been indicated the bulk of the pig iron produced is used in steel-making.

Steel Production

12. Pig iron contains 3 to 4 per cent. carbon, besides smaller amounts of silicon, sulphur and phosphorus, and the process of making steel consists broadly in reducing the carbon content of the pig by oxidizing the carbon in a furnace. The resultant steel is malleable and has a carbon

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content of 1·4–1·6 per cent. or less.* The main methods utilize the open hearth furnace, which permits the use of a high proportion of scrap with the pig iron; the Bessemer converter, which is a hot metal process; or the electric furnace, which uses scrap and a little cold pig iron. In the U.K. (as in the U.S.A.) the bulk of steel is of open hearth basic quality and the proportion has grown steadily since 1920. In France, Belgium-Luxembourg and Germany the steel is mainly of basic Bessemer (Thomas) quality. The following table shows the relative changes in importance of the various qualities in the U.K.

TABLE 6

Percentage Distribution of Steel Output by Process in U.K.

	1920 %	1929 %	1937 %	1948 %	1949 %
Open hearth—acid	37·3	25·4	17·5	9·4	8·8
basic	50·5	67·4	74·5	77·9	78·6
Bessemer—acid	6·5	5·8	2·0	1·5	1·5
basic	4·1	..	3·2	5·3	5·3
Electric	1·0	0·9	1·7	4·7	4·7
All other	0·6	0·5	1·1	1·2	1·1

13. The materials consumed per ton of crude steel produced in 1949 totalled 25·58 cwts, of which pig iron was 9·13 cwts and scrap 12·57 cwts. The following table shows, (*a*) that the proportion of hot and mixer metal to cold pig has risen since 1937; (*b*) that the scrap ratio has risen slightly.

TABLE 7

Crude Steel

All Qualities—Materials Consumed per Ton of Steel Produced

(*Cwts.*)

Process	*Materials Consumed*								
	Pig Iron		*Scrap*						
	Hot and Mixer Metal	*Cold Metal*	*Steel*	*Cast Iron*	*Oxides*	*Finish-ings*	*Fluxes*	*Fettling Materials*	*Total*
1949									
Open hearth—Acid	..	5·79	15·42	0·36	0·45	0·36	0·13	0·56	23·07
Basic	6·14	2·83	12·08	0·58	1·30	0·25	1·95	0·77	25·90
Bessemer—Acid	19·30	0·01	2·45	..	0·01	1·05	..	..	22·82
Basic	22·50	0·10	0·95	..	0·22	0·22	3·32	0·50	27·81
Electric	..	0·36	20·23	0·10	0·33	1·03	0·93	0·39	23·37
Stock converter	..	6·68	14·96	..	..	0·37	0·70	0·11	22·82
Tropenas	..	6·47	16·50	0·06	0·03	0·78	0·79	0·97	25·60
Total, 1949	6·30	2·83	12·08	0·49	1·09	0·31	1·77	0·71	25·58
Total, 1948	6·50	3·00	11·61	0·55	1·17	0·31	1·79	0·72	25·65
Total, 1937	5·94	3·69	10·60	0·91	1·63	0·33	1·72	0·60	25·42

14. The dominance of the open hearth process permits of great flexibility in the industry and the scrap ratio may be varied within fairly wide limits as the balance of economic advantage changes. For the purposes of the following table the scrap ratio is defined as the percentage of scrap to the pig iron and scrap charged to the steel furnace rather than as the proportion of scrap to steel output which is more usual.

* (*a*) Low carbon steels (soft)—up to ·15 per cent. carbon.
(*b*) Mild steels—·15 per cent. to ·25 per cent. carbon.
(*c*) Medium carbon steels—·25 per cent. to ·5 per cent. carbon.
(*d*) High carbon steels—·5 per cent. to 1·4–1·6 per cent. carbon.

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TABLE 8

Scrap Charged as Percentage of Iron and Scrap Consumed

Process	1920 %	1929 %	1937 %	1948 %	1949 %
Open hearth—acid	48	60	66	73	73
basic	42	48	54	56	59
Bessemer—acid	9	9	17	12	11
basic	7	..	7	4	4
Electric	97	99	97	98	98
Average all processes*	41	49	54	56	58

* Including stock converter and tropenas.

15. In 1949, 850,000 tons of oxides were consumed in steel-making in order to reduce the carbon content. Almost two-thirds of this total consisted of iron ore, most of the remainder being mill scale.* Imported ore is used for this purpose because of its greater richness and oxidizing power.

16. In 1949 the output of blast furnace ferro-alloys consisted of 140,000 tons of ferro-manganese and almost 30,000 tons of spiegeleisen. Ferro-manganese is used to produce manganese steels which are tough and resistant to wear. Small amounts of other metals are used in making special steels and these increase the hardness and cutting power of the steel or improve considerably its resistance to rust and corrosion. Such materials are tungsten, molybdenum, vanadium, chromium, added in the form of ferro-alloy to facilitate absorption.

17. At the end of 1949 there were in existence 732 steel furnaces, of which 93 were open hearth (acid), 332 open hearth (basic), 10 Bessemer converters (of which only 2 were acid) and 196 were electric furnaces. The largest number of furnaces found in one district was 185 in Sheffield, followed by South Wales with 137 and Scotland with 111. To form some idea of the relative importance of areas, of course, it is necessary to refer to figures of district steel production—the number of furnaces alone being misleading. Sheffield, for example, is noted for the production of special steels. For these, there are many different specifications, often required in small quantities for which an electric furnace with as little as half a ton capacity may be appropriate. Sheffield has no less than 108 electric furnaces.

The capacity of a Bessemer converter is generally about 25 tons. Although there were only ten of these at the end of 1949 it must be remembered that the process is very rapid (some 20 minutes), so that many more heats per week may be obtained than from the larger open-hearth furnace, where the steel-making process takes 10–20 hours.

18. The bulk of crude steel is teemed into ingot moulds, but a small amount is poured direct for steel castings. Steel production in 1949 was 15,553,000 tons, the highest so far achieved, following on a record-breaking year in 1948. The increased output of steel compared with 1937 is the result of higher output in each steel-producing district and is fairly evenly shared, with the exception of the North-West Coast which shows a small relative decline. It is interesting to note that the production of basic Bessemer quality shows a larger proportionate increase compared with 1937 than does the main process (open hearth), this being due primarily to the resumption of Bessemer production in South Wales.

The production of alloy steel ingots and castings in 1949 totalled 767,700 tons and comprised nickel chrome molybdenum, carbon chrome, manganese molybdenum and other alloy steels. The production of special steels is very largely concentrated in the Sheffield area.

Conversion factors

19. Ingots are rolled into semi-finished products (billets, blooms, slabs) and these in turn are rolled into finished products (bars, plates, sheet, etc.). Metal is lost through shearing, processing and scaling—notably in removing that part of the top of the ingot which contains unavoidable flaws. As a consequence there is a decline in tonnage as a given quantity of ingots moves forward to the finishing processes—a loss which is naturally greater the more highly finished

* Mill scale is the oxide which is detached from the metal during the hot rolling process.

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the product. The waste metal is collected for recharging to the steel furnaces—this "circulating scrap" supply augmenting supplies of process scrap (thrown up by engineering firms) and capital scrap, which is the result of the junking of obsolete equipment.

In order that the output of the various products should be reduced to homogeneous units a conversion factor must be used. A convenient way of doing this is to take the weighted average of finished product weights, expressed as a percentage of ingot weight. This is approximately 72 per cent. Thus a particular magnitude—steel production, home consumption of steel, etc.—may be expressed in two ways, either as x ingot tons or as $\cdot 72x$ finished steel tons.* Since the conversion factor differs for each product, the overall figure will depend on the pattern of production and, as a consequence, and also because of technical differences, the conversion factors in use in various countries will not be the same. This should be borne in mind in making comparisons between countries.†

TABLE 9

Conversion Factors
Finished Steel and Ingot Weights

Product (1)	*Conversion Factors*			*Weighting % of total deliveries in 1949* (5)
	Cwts. of Ingot per ton of Product (2)	*Finished weight as % of ingot weight* (3)	*Add % to finished weight to give ingot weight* (4)	
Non-Alloy				
Forging billets	26·5	75·5	32·4	0·49
Re-rolling billets	23·5	85·0	17·6	0·23
Wire rods	24·7	81·1	23·6	0·14
Rails	26·1	76·6	30·6	4·34
Plates	28·8	69·3	44·2	16·55
Other heavy products	24·6	81·4	22·9	12·76
Light rolled products	25·9	77·3	29·4	19·48
Cold rolled strip	25·7	77·9	28·5	1·97
Bright steel bars	27·3	73·2	36·6	2·53
Sheets	27·3	73·4	36·3	11·79
Tinplate	27·7	72·3	38·4	6·01
Tubes	31·5	63·5	57·5	7·88
Mild steel wire	25·2	79·3	26·1	5·21
Hard steel wire	26·1	76·5	30·7	1·42
Tyres, wheels, axles	31·6	63·3	58·0	1·81
Drop forgings	34·6	57·8	72·9	1·68
Other forgings	50·0	40·0	150·0	0·99
Castings	36·0	55·6	79·8	1·57
Weighted average: Non-alloy	27·6	72·5	38·0	96·85
Alloy				
Billets	26·6	75·8	33·3	..
Tubes	40·0	50·0	100·0	0·24
Armour plate	40·0	50·0	100·0	0·01
Bars, sheet, strip, wire	30·0	66·7	50·0	1·41
Drop Forgings	37·0	54·1	85·0	0·90
Other forgings	50·0	40·0	150·0	0·28
Castings	38·4	52·1	91·9	0·31
Weighted average: Alloy	35·4	56·5	77·0	3·15
Weighted average: All steel	27·9	71·7	39·5	100·00

NOTE.—The weighting in column (5) is proportional to the total net deliveries of each product in 1949; i.e. material for conversion from one product to another more highly finished product included in the above list is omitted.

* Alternatively a given tonnage of finished steel may be converted back to its ingot equivalent by the addition of 40 per cent. of finished steel weight.

† See, e.g. *European Steel Trends*, United Nations, p. 5 (1949).

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Finished Steel Products

20. The steel industry produces a great variety of finished products. Some ambiguity is necessarily involved in the use of the word "finished." Plates, e.g., are finished products but they may subsequently be made into tubes, which are also finished products. Alternatively, tubes may be made from another finished product, hot rolled strip. Clearly, if the tonnages of such finished products were added together, duplication would occur in the resultant total. Finished steel production figures should, therefore, not be aggregated, unless some deduction for intra-industry conversion is first made. Table 10 shows the deductions made for intra-industry conversion in arriving at the figure of net deliveries for 1948 and 1949.

TABLE 10

Finished Steel Deliveries
(000 *tons*)

	1948	1949
Gross deliveries from U.K. production	12,463·4	13,358·4
Add: From other U.K. sources (secondhand material, etc.)	298·9	307·1
Imports of finished steel	178·8	399·6
Total: Gross deliveries	12,941·1	14,065·1
Deduct: Material for intra-industry conversion	1,820·8	2,043·2
Total: Net deliveries	11,120·3	12,021·9

21. As Table 11 shows, there have been marked changes in the pattern of finished steel output between 1937 and 1949. The most notable of these are the increases recorded for drop forgings, cold rolled strip, bright bars and light sections. The reduction in the case of tinplate is due to the fact that requirements were low in war-time and considerable difficulty has since been experienced in expanding the labour force.

TABLE 11

*Production of Finished Steel**: 1937 *and* 1949

Product	1937 (000 *tons*)	1949 (000 *tons*)	% (+) *or* (−) *of* 1949 *on* 1937
Heavy rails, sleepers, etc.	518	537	+ 3·7
Heavy and medium plates (including armour)	1,624	2,039	+ 25·6
Other heavy rolled products	2,018	1,879	− 6·9
Light sections and bars†	1,515	2,539	+ 67·6
Hot rolled hoop and strip	663	898	+ 35·4
Cold rolled strip	130	284	+118·5
Bright bars	179	340	+ 89·9
Sheets, coated and uncoated	1,272	1,462	+ 14·9
Tin, terne and blackplate	958	751	− 21·6
W.I. and steel tubes, pipes and fittings	760‡	990	+ 30·3
Wire	600‡	791	+ 31·8
Tyres, wheels and axles	158	243	+ 53·8
Drop forgings	140‡	311	+122·1
Other forgings	150‡	163	+ 8·7
Steel castings	170	236	+ 38·8

* Includes material for further conversion.
† Includes ferro-concrete bars and colliery arches but excludes wire rods.
‡ Estimated.

22. The specialization by districts on particular products results in important economies. As Table 12 shows, the North-East Coast concentrates on heavy products and accounts for 45 per cent. of the total production of heavy rails, etc., nearly 40 per cent. of the output of heavy sections

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and over a third of the production of plates, while its ingot production is only some 20 per cent. of the total. In South Wales, with a similar ingot production, the emphasis is on flat products. No less than 98·5 per cent. of the output of tinplate, about 30 per cent. of the output of cold rolled strip and a little more than 50 per cent. of the production of sheets was concentrated in South Wales. In Sheffield is concentrated the production of special steels. Here is made three-quarters of the country's production of alloy steel products and 98·7 per cent. of its high-speed steel.

TABLE 12

Percentage Distribution by District of U.K. Steel Production in 1949

Product	*District*									
	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
Ingots	4·0	7·7	0·5	9·7	20·7	15·2	4·9	21·2	13·5	2·6
Heavy rails, sleepers, etc.	—	0·2	—	0·1	45·0	14·3	2·8	19·5	—	18·1
Heavy and medium plates (including armour plate)	—	2·1	—	17·4	36·8	31·1	3·0	8·3	1·3	—
Heavy sections	1·2	1·8	0·2	9·3	39·8	18·2	19·9	1·3	8·3	—
Light sections and bars*	1·0	8·1	0·7	3·4	18·5	10·3	21·8	11·8	23·2	1·2
Hot rolled hoop and strip*	42·4	2·9	—	—	4·9	1·5	13·9	12·6	19·4	2·4
Ferro concrete bars	—	0·6	0·5	9·5	16·3	7·2	—	55·1	10·8	—
Cold rolled strip*	12·8	2·3	—	—	—	0·7	23·3	30·6	30·3	—
Bright bars*	0·1	25·9	6·2	—	—	6·2	41·8	4·6	15·1	0·1
Sheets*	—	28·8	—	—	5·4	5·2	5·5	54·4	0·7	—
Tinplate	—	—	—	—	—	—	2·4	97·6	—	—
Tubes, pipes, fittings	30·9	—	0·2	—	4·5	18·0	36·7	8·6	1·1	—
Wire*	0·9	42·9	17·2	—	4·6	3·1	7·4	15·2	8·7	—
Tyres, wheels and axles	—	40·0	—	—	0·7	1·3	—	4·1	53·9	—
Drop forgings	7·6	2·9	5·0	3·6	6·8	7·5	48·9	1·5	16·2	—
Other forgings	4·8	8·6	0·9	1·5	6·5	14·2	12·7	0·1	50·1	0·6
Steel castings	7·5	5·4	5·9	1·8	18·4	19·4	13·2	5·1	21·9	1·4
High speed steel	—	—	1·2	—	—	—	0·1	—	98·7	—
Alloy bars, plates, sheet, strip, etc.	1·5	0·9	1·2	—	0·2	13·1	2·7	1·6	76·7	2·1

* Excludes alloy. — *Nil* or negligible.

Key to B.I.S.F. Districts

1. Derby, Leicester, Notts, Northants and Essex.
2. Lancs (other than 10), Denbigh, Flint and Cheshire.
3. Yorkshire (other than 5 and 9).
4. Lincolnshire.
5. North-East Coast.
6. Scotland.
7. Staffs, Salop, Worcs, Warwicks.
8. South Wales and Monmouth.
9. Sheffield (including a works in Manchester for which separate particulars are not available).
10. North-West Coast.

23. Statistics of imports (and exports) of iron and steel products in Federation publications differ from those given in the Trade and Navigation Accounts, in that they include railway tyres, wheels and axles from Class III, Group S, in addition to "iron and steel and manufactures thereof" from Class III, Group C. Classs III, Group C, is often used to indicate trade in iron and steel, although it is a wider grouping which includes certain iron and steel manufactures as well as iron and steel products proper.

The manufactured items may be deducted from the totals given in the Trade and Navigation Accounts in order to reach a total of iron and steel products proper. Federation statistics give a breakdown showing the total of such items separately, so that the adjustment is easy to make. It is also possible to eliminate these items from the import and export figures for each country by using the Federation statistics, although it is not possible to make this adjustment from the information given in the Trade and Navigation Accounts.

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Consumption by Industry Statistics

24. Figures of steel deliveries are known but there has been no corresponding information on the distribution of consumption by industry. The statistics arising from the former steel distribution scheme were based on departmental symbols which permitted estimates of the consumption by individual industries to be made only after a laborious and somewhat arbitrary procedure.* It was in the sphere of distribution statistics that the greatest single improvement in steel statistics was to be made and the introduction of a new set of symbols on an industry basis in June, 1950, is greatly to be welcomed.†

The official control over the distribution of general steel (but not sheets and tinplate) ended on May 27th, 1950, and the Iron and Steel Utilization (Records) Order, 1950, which came into force on June 4th, 1950, provides authority for the industry to continue to collect statistics of deliveries of steel to consuming industries. Summaries of this information will subsequently be published. An indication of the coverage of the new industry symbols and the appropriate minimum list headings of the Standard Industrial Classification are shown below. For sheets and tinplate, deliveries will continue to be classified by departmental symbols.

U.K. Steel Distribution Statistics

Industry Headings	*S.I.C. Minimum List Headings*
Coalmining (excluding open-cast)	10
All other mining and quarrying	11, 12, 13, 14, 19
Iron and steel	40–44
Shipbuilding and ship-repairing	50
Marine engineering	51
Agricultural machinery (excluding tractors)	52
Boilers and boiler house plant	53
Machine tools	54
Textile machinery and accessories	56
Constructional engineering	58
Other non-electrical engineering	55, 57, 69
Electrical machinery and apparatus	70–75, 79
Manufacture and repair of motor vehicles (including tractors), cycles and aircraft (including parts and accessories)	80–83
Manufacture and repair of rolling stock by Railway Executive	84, 86(1)
Manufacture and repair of rolling stock by all other makers	85, 86(2)
Bolts, nuts, screws, rivets, nails, etc. (other than wire)	91
Drop forgings, laminated springs, anchors, chains, etc.	92
Wire manufactures (excluding springs, needles, pins)	93
Hollow-ware	94
Metal furniture, windows, coil and spiral springs, needles, pins, etc.	99
Tools, implements, cutlery, instruments, watches, etc.	90, 100, 101
Building and contracting (including open-cast mining)	200–201
Gas, electricity and water	210–212
Railways (excluding rolling stock)	220
Other U.K. consumers	241(2)
Stockholding steel merchants	
Deliveries for direct export	

* See article: "Steel Consumption by Industry" in *B.I.S.F. Monthly Statistical Bulletin*, July, 1950.

† Statistics of distribution by end-use are published regularly in the United States and Canada. In the General Report to the I.L.O. Iron and Steel Committee (1949) attention was drawn to the problem as follows: "Only Canada and the United States appear to publish such statistics regularly. . . . Yet this information, regularly available, is essential for any scientific attempt to forecast the future relationship between the demand for and supply of steel or to plan for greater regularity of employment in the industry" (General Report, p. 76). Subsequently the Committee adopted a resolution incorporating a recommendation to the countries concerned.

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Supply and Usage of Steel

25. Table 13 shows the supply and usage of steel in 1949. The figures used for home investment and consumption and "indirect" exports are, of course, estimated.

TABLE 13

The Supply and Disposal of Steel in 1949
(*Million tons—ingot and ingot equivalent*)

U.K. production	15·6		Direct Exports	2·5
Increase in producers' stocks	0·3		"Indirect" exports*	3·1
		15·3	Home investment and consumption*	11·0
Imports		1·1	Increase in merchants' and consumers'	
Re-usable material		0·5	stocks*	0·3
Total supply		16·9	Total disposal	16·9

* Estimated.

Estimates of pre-war consumption of steel by industry have been made by the Federation* and are based partly on those of the Census of Production, 1935. The estimate of the steel content of the exports of steel-using industries ("indirect" steel exports) is obtained by applying the percentage of the output each industry exported in 1935 to its estimated steel consumption in that year.† Comparable figures for 1938 and post-war years are obtained by making adjustments for changes in the volume of finished goods exported as calculated by the Board of Trade.

Stocks

26. Figures of apparent home steel consumption may be obtained as a residual by adjusting production figures for imports and exports. To obtain figures of actual usage it is also necessary to know stock changes and supplies of re-usable material. So far as Europe is concerned, the Rollman Report (*European Steel Trends*) points out that "the United Kingdom is the only country where estimates have been published for increases in inventory"; in all other cases figures of apparent consumption only are available.

Figures of producers' stocks, published in the *Year Book* and the *Bulletin*, consist mainly of ingots and semis. Details of stock changes are also obtained from stockholding merchants, while twice a year a census is carried out of consumers' stocks and usage of steel. Details of overall changes in stocks are included in the steel supply and disposal tables published from time to time in articles in the *Bulletin*. In addition, the *Year Book* and the *Bulletin* show stocks of pig iron and of iron and steel scrap.

Fuel Statistics

27. Since fuels cost the industry £70 to £80 million a year, nearly one-fifth of the total costs, it is of great importance that there should be efficient use of fuel. Economies in the use of fuel involving larger outputs of pig iron from the blast furnace with a given intake of coke, have been achieved, so that coal consumption per ton of finished steel has fallen from 62·7 cwts. in 1923, to 40·7 cwts. in 1938 and 36·1 cwts. in 1949. The post-war improvement was obtained in spite of a decline in the quality of the coal supplied.‡ (Similarly, the coal used per ton of pig iron produced, which was 44·4 cwts. in 1920, was only 31·5 cwts. in 1949). As a consequence, more steel was produced in 1949 with less fuel than in 1948.

28. During the war an arrangement was made with the Ministry of Fuel and Power for the Iron and Steel Control (of the Ministry of Supply) to be responsible for collecting statistics of solid fuel consumption. Under the allocation arrangements firms had to return their total con-

* See articles in *B.I.S.F. Monthly Statistical Bulletin*, May, 1946, and July, 1950.
† See article in *B.I.S.F. Monthly Statistical Bulletin*, May, 1948.
‡ For further details see "Fuel Efficiency in the Steel Industry"—B.I.S.F. *Monthly Statistical Bulletin*, February, 1950.

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sumption, not merely that relating to their iron and steel activities. The scheme was subsequently extended to include not only iron and steel firms, but also those firms responsible for essential supplies to them. For both these reasons the official figures included a margin of consumption not related to the iron and steel industry. This margin has been eliminated from the 1948 and 1949 figures in the 1949 *Year Book*.

29. Steel furnaces may be fired by surplus coke oven gas, producer gas or liquid fuels. The change to liquid fuels, mainly oil, has been marked during the post-war period and at present about a third of the basic open hearth furnaces are oil-fired. Oil firing offers superior heating facilities to gas firing and means cleaner handling. The use of oil is less common with acid furnaces because of the possibility of sulphur absorption.

TABLE 14

Liquid Fuels Consumed in the Iron and Steel Industry
(Excluding Iron Foundries)
(000 *tons*)

	1948		1949	
	Steel Furnaces	*Total*	*Steel Furnaces*	*Total*
Tar	34·5	49·5	66·1	79·6
Creosote-pitch	68·8	96·8	119·4	146·4
Fuel oil	558·1	737·6	561·9	775·9
Gas and diesel oil*	..	4·6	..	4·4
Total	661·4	888·5	747·4	1,006·3

* Excluding consumption in internal combustion engines.

30. The industry is a heavy consumer of electricity, using some 4,000 million units in 1949, primarily to operate rolling mills which require a very high input of power. The figures for 1949 are compared in Table 15 with consumption in the Census year, 1935.

TABLE 15

Electricity Consumed by the Iron and Steel Industry

	Million units	
	1935*	1949†
Generated in own works	618	1,299
Generated in other works under same ownership	265	2,845
Purchased	731	
	1,614	4,144
Sold	..	220
Consumed	1,614	3,924

* Excludes iron and steel foundries.
† Excludes iron foundries only.

Measures of Output

31. The various attempts to construct an index of production for the iron and steel industry may now be examined. Difficulties arise mainly from the fact that the industry consists of a number of successive processes (iron-making, steel-making, primary rolling, finishing) with an increasingly heterogeneous output. At the finishing end the diversity of output and the danger of duplication make it inaccurate to base an index on the total tonnage of finished products, while the *value* of finished output cannot be estimated without comprehensive and detailed information

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about iron and steel prices or costs. The output of the earliest stage (i.e. of pig iron) on the other hand, is an inadequate indicator of activity in the industry, since it is possible to use varying proportions of scrap to pig iron to obtain finished output; nor does it allow for changes in the pattern of finished production. As a measure of activity, the output of crude steel is also subject to this second limitation, besides being unaffected by changes in activity in iron foundries and wrought iron works. The same considerations apply to the output of semis. The fact that—whatever the basis of the index—allowance has to be made for imports and exports of iron and steel products, further complicates the problem.

A brief description of the six main indices is given below.

*Pre-war B.O.T. Index**

32. For the years 1927 to 1938 and the first half of 1939 the Board of Trade published a quarterly index of industrial production with sub-indices for the constituent industrial groups, including iron and steel. At first the index was based on 1924 = 100 with the individual industry groups combined in accordance with their relative net output as recorded in the 1924 Census of Production. In 1935 the index was revised and, among other changes, the base year was changed to 1930, the date of the Fourth Census of Production.

The construction of the iron and steel sub-index is shown in the following table, where the last column contains the weights based on the 1930 Census, expressed as percentages of the total weight of all groups.

Trade	*Indicator*	*Weight* %
Pig Iron	Quantity produced	·4
Crude steel	Output of ingots and castings	1·0
Finished steel	Retained imports of ingots, semis, special steel and tube strip. Output of ingots and castings.	6·6
Tinplate, galvanized	Production of tin, terne and blackplate, galvanized sheets, wire rods.	1·0
Total iron and steel		9·0

The annual index numbers for Iron and Steel and for the total index were as follows:

	1924 = 100		1930 = 100	
Year	*Iron and Steel*	*All Groups*	*Year*	*Iron and Steel*	*All Groups*
1927	110·0	106·8	1934	115·7	106·2
1928	102·3	105·5	1935	125·6	113·4
1929	114·0	111·8	1936	150·1	124·4
1930	88·8	103·2	1937	166·6	132·8
1931	65·9	93·7	1938	131·5	124·1
1932	66·2	93·3	1939—first half	162·8	132·2
1933	82·2	98·6			
1934	102·6	110·8			

Original E.C.E. Index†

33. In their *Survey of the Economic Situation and Prospects of Europe*, published in 1948, the Research and Planning Division of the Economic Commission for Europe produced an index of U.K. iron and steel production, which may be regarded as a continuation of the B.O.T. index. It is a quarterly index for 1946 and the first three-quarters of 1947, with 1938 = 100. The index is based on 6 series, of which only the "principal series" are specified: pig iron, steel ingots and castings, tubes, wire. It forms part of two wider index numbers: (*a*) an index of U.K. industrial

* For a more detailed description of this index, see *Board of Trade Journal* for July 26th, 1928 (pp. 104–107) and March 28th, 1935 (pp. 515–517).

† For description see *A Survey of the Economic Situation and Prospects of Europe*, Geneva, 1948, published by U.N. Department of Economic Affairs, pp. 191–2.

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production (Table XLIX), in which the individual groups are weighted on the basis of their net value of output in 1935, iron and steel having 10 per cent. of the total weight, and (*b*) an index of European iron and steel production (Table 4), in which the individual countries are weighted in proportion to the net value of their iron and steel output in 1938, expressed in U.S. dollars of 1938 purchasing power, the U.K. being given 22·4 per cent. of the total weight. This high percentage is due to the fact that the U.S.S.R., Czechoslovakia, Hungary, Austria and some smaller steel producers are excluded from the index.

The published U.K. iron and steel production indices (1938 = 100) are as follows:

1946—1st quarter,	113·4	1947—1st quarter,	101·5
2nd ,,	115·3	2nd ,,	116·0
3rd ,,	109·5	3rd ,,	110·0
4th ,,	120·1		

In the *Economic Survey of Europe in 1948*, prepared by the same organization in 1949, the above index is discontinued. No separate index for British iron and steel production is published, but use is made of the metals, engineering and vehicles sub-index of the official U.K. Interim Index of Production.

*Financial Times Index**

34. The *Financial Times* Index of Production, first published in July, 1946, is based on the consumption of industrial raw materials except for its largest single constituent—steel—which is in terms of the production of steel ingots and castings plus imports of ingots and semis. It is a monthly index based on 1944 = 100, the sub-index for steel being published separately. The weights used to combine the seven sub-indices are the consumption of the materials concerned in 1944. Steel is given 31·7 per cent. of the total weight.

London and Cambridge Index

35. The Index of Industrial Production prepared by the Cambridge University Department of Applied Economics and published in the *Bulletin* of the London and Cambridge Economic Service was started early in 1948 and is based on 1946 = 100, with partial links to the year 1935 based on somewhat different data. It is a monthly index, the individual industry groups being weighted in proportion to their estimated net output in 1946. There is no separate sub-index for iron and steel but a joint index for Metal Production which includes the production of non-ferrous metals. The construction of this sub-index was revised in February, 1949.

(a) *Earlier version*†.—Originally the iron and steel section of the sub-index for Metal Production was composed as follows:

Trade	*Indicator*	*Weight* %
Metalliferous mines and quarries	Output of iron ore	0·14
Blast furnaces	Output of pig iron	0·35
Iron and steel smelting and rolling	Output of steel ingots and castings	1·95
Tinplate, Wrought iron and steel tubes, Wire	Net deliveries of finished steel	1·95
Total of above trades		4·39

While the weight of the ferrous section is 4·4 per cent., that of the non-ferrous section is 1·8 per cent., making a total of 6·2 per cent. for the Metal Production index. Iron and steel foundries are not included in this sub-index but in that for the Other Metal-Using Trades.

The authors of the index, aiming at a high statistical standard, admitted their "cavalier treatment of the problems posed by the main group of iron and steel industries" in that they

* See special articles in *Financial Times*, July 22nd and 23rd, 1946.

† See C. F. Carter, W. B. Reddaway and R. Stone, *The Measurement of Production Movements*, 1948, especially pp. 79 and 89.

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"should have paid more regard to the different types of finished steel for which the average net output content per ton varies"—a consideration of particular importance for long-term comparisons.

(b) *Present version.*—The authors of the Cambridge index were able to remedy this defect by replacing their original indicators for steel-making and finishing (i.e. output of ingots and castings and net deliveries of finished steel) by an index for steel melting and rolling prepared by the British Iron and Steel Federation (see below) and indicators for the production of tinplate, tubes and wire.

*C.S.O. Interim Index**

36. The Interim Index of Industrial Production, prepared by the Central Statistical Office, which appeared soon after the Cambridge Index, resembles the latter in many respects. It is a monthly index based on 1946 = 100, is weighted by estimated relative net output in 1946 and gives 1935 index numbers for the major industrial groups. But it publishes a separate index for iron and steel production ("Metal Manufacture—Ferrous") which, following the Standard Industrial Classification, excludes iron ore mines but includes iron and steel foundries. The details are as follows, although the series and weights used for comparisons with 1935 were slightly different.

S.I.C. heading	*Indicator*	*Weight* %
40	Output of pig iron	·26
41	Output of ingots and castings; net deliveries of finished steel (excluding tinplate, tubes and wire)	2·34
42	Output of iron castings	·61
43	Output of tin, terne and blackplate	·17
44	Deliveries of steel tubes	·42
40–44		3·80

The index numbers so far available for "ferrous metal manufacture" (1946 = 100) are given below:

	Year			
	1946	1947	1948	1949
Annual Average	100	102	116	123

B.I.S.F. Index†

37. To meet the point regarding different values of steel products, referred to above, the British Iron and Steel Federation has prepared an index of changes in the "volume" of output in steel melting and rolling since before the war. The coverage of the index is similar to that of the Census of Production group "Iron and Steel Trade (Melting and Rolling)" and to the sum of the Standard Industrial Classification headings 41 and 43 (sheets only). In order to allow for changes in the pattern of finished output, which may be considerable over a lengthy period, the index is based on the output, suitably weighted, of 24 separate finished steel products or groups of products. In this respect it is similar to the index of finished steel production published by the London and Cambridge Economic Service before the war.‡ However, the weights used by the Federation to combine the individual product series are the average prices (f.o.r. supplier's works) realized in the fourth quarter of 1947 for each of those products. They are adjusted so as to exclude the cost of pig iron and scrap consumed in the production of each product, thus yielding an index of the net value of output (at constant prices) in steel melting and rolling, allowance being made for the import and export of ingots and semis. In this context "net value of output" differs from the Census of Production definition of the term, since it is gross of all materials and fuel other than pig iron and scrap.

* See *The Interim Index of Industrial Production* (Studies in Official Statistics No. 1, H.M.S.O.), June, 1949, especially p. 36.

† See article in *British Iron & Steel Federation Statistical Bulletin* for August, 1948. A more detailed description of the index is available on application to the Federation.

‡ See *L.C.E.S. Bulletin* for May 23rd, 1939, p. 229.

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The base year of the index is 1938 and index numbers have been worked out for the following years:

1935	98	1945	127
1937	131	1946	135
1938	100	1947	139
		1948	159
		1949	167

Monthly index numbers are now calculated and supplied to the Department of Applied Economics, Cambridge, for use in their index. Like the Cambridge and C.S.O. indices, the B.I.S.F. index makes no correction for seasonal factors, and the monthly indices are based on weekly averages for the statistical month of 4 or 5 weeks.

The relative merits of these indices may be summed up as follows. The C.S.O. index is the only currently published index of iron and steel production. Of the two indices of steel production only, the B.I.S.F. index is much more refined than the F.T. index, being so far the only index to make proper allowance for changes in the pattern of output. It has the additional merit of providing a comparison with three pre-war years. The Cambridge index, as published, unfortunately covers all metal production, including that of non-ferrous metals. For the pre-war period the B.O.T. index (of which the original E.C.E. index may be regarded as an extension) gives an adequate measure, especially of short-period changes.

Employment and Unemployment

38. Figures of numbers employed, subdivided into industrial groups, are published monthly in the *Ministry of Labour Gazette*. Under the heading "metal manufacture" separate figures are given for blast furnaces, iron and steel melting and rolling, iron foundries, tinplate, steel sheet and iron and steel tubes, totalling in January, 1950, 402,900 persons. Care must be exercised in using such information over a period since what is meant by an insured worker changes with each change of statutory definition. In 1941 the scope of insurance was extended to include non-manual employed persons earning less than £420 per annum, the previous limit having been £250 per annum. A new and broader scope for the statistics emerged in 1948 with the introduction of the national insurance scheme. Employees over pensionable age are now included; there are no exceptions on grounds of remuneration; all non-manual workers and employers are also included, although the latter are excluded from the industrial breakdown.*† The position was further complicated by the parallel introduction of a new grouping based on the Standard Industrial Classification (as amended in the *Ministry of Labour Gazette*, Feb. 1949, p. 47). Some of the major changes affecting iron and steel were as follows: (*a*) the rolling of sheets from sheet bars and slabs was taken out of the steel melting, rolling, etc., category and given a separate group; (*b*) the production of tube ingots and semis in integrated works was transferred from steel melting, rolling, etc., to the tube group; (*c*) the manufacture of steel railway springs was transferred from steel melting, rolling, etc., to the forgings group; on the other hand, (*d*) engineers' steel founding—formerly in the general engineering group—is now in steel melting, rolling, etc.

The difficulty of disentangling steel-making from engineering is evidenced by the fact that in 1943 the Ministry of Labour discovered that a number of engineering workers had been wrongly classified as occupied in steel-melting, etc., so that a revised figure for mid-1939 was published in 1946, reducing the number in steel-melting, etc., processes from 178,400 to 160,000. No adjustment is available for years earlier than 1939.

In the *Gazette* is also to be found a similar analysis of the numbers unemployed showing those persons "temporarily stopped" and those "wholly unemployed (including casuals)."

39. The Federation collects and publishes its own material of the average numbers employed in the industry and this information is available from 1940. These figures show a sharp drop between 1943 and 1944 because of the exclusion of workers temporarily absent. This information is sub-divided to show, e.g. for 1949, that of a total male labour force of 293,369 (excluding iron foundries, bolt and nut manufacture and ferro-alloy manufacture), process workers totalled 184,201, general and maintenance workers 91,978 and clerical workers 17,190.

* Cf. *Ministry of Labour Gazette*, February, 1949, pp. 40–41.

† For information regarding the position before these changes see *Guide to Official Sources*, No. 1, Labour Statistics, H.M.S.O., 1948.

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For process workers the Federation figures show a more detailed classification than those given in the *Gazette*, whereas the Ministry figures show a breakdown for all employed persons.

Earnings and Hours

40. Twice a year in its *Gazette* the Ministry of Labour publishes information regarding earnings and hours. This is based on the Standard Industrial Classification and is, therefore, not fully comparable with information before October, 1948. The Ministry figures are given for "metal manufacture" and its sub-groups separate non-ferrous from ferrous metal production.

41. Table 16 shows average weekly earnings, numbers employed and the weekly wage bill based on Federation statistics. The information is derived from data submitted in respect of one week in each calendar month.

TABLE 16

Average Earnings, Numbers Employed and the Wages Bill in the Iron and Steel Industry

		1946	1947	1948	1949
Average weekly earnings per worker	(£)	6·07	6·41	7·13	7·53
Number employed		298,239	304,442	314,782	318,335
Wage bill (weekly)	(£ mns.)	1·81	1·95	2·24	2·40

Details of average hourly and weekly earnings and average hours worked are given in Table 17. These Federation figures show that workers in the steel-melting group, with an average weekly wage of £9 10*s.*, are the highest paid. Separate figures are also given for maintenance and clerical workers. The Federation figures differ from those of the Ministry of Labour since the dates and definitions of the industry differ, and the Federation figures give a detailed breakdown.

TABLE 17

Numbers Employed, Average Hours Worked and Average Earnings in the Iron and Steel Industry—Week Ended March 4th, 1950*

Branch of industry	*Numbers† employed*	*Average hours worked per worker*	*Average earnings per worker*	
			Hourly	*Weekly*
	No.	*No.*	*s. d.*	*£ s.*
Process workers:				
Iron ore mines and quarries	4,856	44·8	3 3	7 5
Coke ovens at blast furnaces	3,346	47·8	3 3	7 16
Blast furnaces and sintering plants	11,130	48·4	3 4	8 0
Steel melting furnaces and ancillary processes (excluding melting for manufacture of steel castings)	21,508	47·6	4 0	9 10
Rolling mills and ancillary processes (excluding wrought iron, sheet and tinplate rolling, but including bright bars)	46,559	45·7	3 6	8 0
Sheet making	17,866	45·0	3 8	8 5
Tinplate manufacture	13,322	41·6	3 6	7 7
Forges and ancillary processes:				
(*a*) Drop forges	10,006	44·4	3 7	7 19
(*b*) Other	8,064	45·6	3 4	7 12
Steel foundries and ancillary processes (including melting for manufacture of steel castings)	19,187	46·9	3 3	7 14
Wire drawing, wire rope and wire netting manufacture and ancillary processes	17,377	46·1	2 11	6 15
Wrought iron manufacture	2,098	43·5	3 0	6 12
Steel and wrought iron tubes and fittings manufacture	21,174	45·4	3 3	7 7
Average (process workers)	196,493	45·8	3 5	7 18
General and maintenance workers associated with above processes	98,055	49·3	3 2	7 17
Clerical workers associated with above processes	27,847	40·3	3 0	6 2
Average	322,395	46·4	3 4	7 14

* Excluding iron foundries, bolt and nut manufacture and ferro-alloys (other than blast furnace ferro-alloys).

† Two part-time female workers taken as equal to one person.

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Industrial Disputes

42. Figures of industrial disputes are given monthly in the *Ministry of Labour Gazette*, together with comparisons between similar periods for the current and preceding year. Such information has been collected since 1893. Separate figures for iron and steel were published in the *Gazette* for 1928–31 only; for other years up to 1949 inclusive the figures relate not only to iron and steel but also to "other metals." This can be very misleading. In 1948, for instance, 531,000 working days are recorded as having been lost through disputes in "Iron and Steel and Other Metal," but of this total only 16,000 days were lost in Iron and Steel. From January, 1950, the basis is that of the Standard Industrial Classification and separate figures for iron and steel are now published annually.* The following table—hitherto unpublished—of industrial disputes in the iron and steel industry since 1920 has been supplied by the Ministry of Labour. The industry is defined so as to exclude the production of tubes, wire and tinplate.

TABLE 18

Disputes in the Iron and Steel Industry

Year	*Number of stoppages beginning in year*	*Number of workers involved in stoppages beginning in year* (000's)	*Aggregate number of working days lost in all stoppages in progress during year*	
			Iron and steel (000's)	*All industries* (000's)
1920	28	61·4	603	26,567
1921	5	2·0	23	85,872
1922	17	3·5	90	19,850
1923	8	3·3	14	10,672
1924	16	18·5	627	8,424
1925	5	0·8	7	7,952
1926*	8	3·7	68	147,233
1927	3	0·4	6	1,174
1928	6	0·8	5	1,388
1929	7	3·1	56	8,287
1930	5	0·6	9	4,399
1931	6	0·5	2	6,983
1932	1	0·1	under 1	6,488
1933	3	0·3	1	1,072
1934	3	0·2	under 1	959
1935	3	0·1	under 1	1,955
1936	5	2·1	8	1,829
1937	15	3·1	6	3,413
1938	8	1·7	7	1,334
1939	9	2·1	13	1,356
1940	10	2·7	16	940
1941	36	5·3	22	1,079
1942	27	3·3	7	1,527
1943	29	4·4	15	1,808
1944	34	9·8	40	3,714
1945	17	2·6	19	2,835
1946	28	9·2	101	2,158
1947	20	5·0	18	2,433
1948	24	4·2	16	1,944
1949	25	7·1	25	1,808

* Excluding General Strike.

Productivity

43. An index of productivity in steel melting and rolling has been constructed (1938 = 100) based on the Federation's production index and the number of insured workers in employment in the Ministry of Labour steel melting and rolling, etc. group (including sheets) which approximately corresponds to the output group. Separate figures for all workers and operatives are

* *Ministry of Labour Gazette*, May, 1950, p. 158.

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provided by the Ministry. The following table gives the results of the investigation, the main problems in connection with which relate to the index of production discussed above.*

TABLE 19

Net Output per Man-year in Steel Melting and Rolling
(1938 = 100)

Year	*All workers*	*Operatives**
1935	112	111
1937	116	116
1938	100	100
1945	107	111
1946	115	119
1947	115	120
1948	126	132
1949	131†	136†

* Process, general and maintenance workers—excluding clerical, administrative and technical workers who are included in "all workers."

† These figures are based on employment figures which are not strictly comparable with the earlier ones because of changes in the official labour statistics due to changes in (*a*) the statutory definition of an employed person, and (*b*) the introduction of the Standard Industrial Classification (see para. 38 above). An adjustment has therefore been made in the 1949 figures.

When interpreting these figures it is important to remember that the labour figures by which the output index is divided are based on employment statistics, i.e., workers on the pay-roll, so that they are not influenced by holidays. The effect of holidays on output is therefore fully reflected in the productivity index. Changes in the figures may reflect many things: an improvement in efficiency on the part of the workers; changes in the number of hours worked in a week, length of holidays, capitalization per worker, in raw materials, methods, managerial efficiency or a combination of these factors.

Information regarding labour turnover and industrial accidents is given in the *Ministry of Labour Gazette*.

Prices

44. The Board of Trade monthly index of wholesale prices includes a sub-index for iron and steel. The 36 items on which the sub-index is based are iron ore (1), pig iron (6), finished iron (4), steel scrap (1), steel semis (3), finished steel (18) and three items of steel manufactures.† Items are weighted equally,‡ so that a change in the price of, say, fishplates, is allowed to have as full an effect as for a quantitatively more important item, such as rails.

Duplication is avoided by the careful selection of items. Thus, basic pig is not included, although more important than hematite, since there is a quotation for basic billets and much of the finished steel is basic quality. The other pig irons are all foundry or forge types so that the question of duplication with finished steel does not arise. Similarly, the iron quotations are all in respect of wrought iron products. The list of finished steel excludes light sections and bars, which seems a considerable omission. It is hardly compensated for by the inclusion of basic billets from which such products are largely rolled.

* See also an article in the *B.I.S.F. Bulletin*, August, 1948.

† Figures in brackets are the numbers of quotations. Full details are given in the *Monthly Bulletin*.

‡ Except that hematite pig iron has a weighting of 2, so that the total "weight" for iron and steel is 37 out of a total of 200 for the whole index. The heavy weighting for iron and steel is intended to compensate for the omission of engineering products from the index. Comparisons between the sub-index for iron and steel and the index for "all articles" are thus somewhat misleading since iron and steel is itself such an important part of the total. This difficulty may be overcome by excluding iron and steel from the total index, i.e. by constructing a sub-index of "all other articles." In June, 1950, the sub-index for iron and steel stood at 187·3, compared with 269·5 for "all other articles" and 252·3 for "all articles."

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The Federation also publishes in the *Statistical Year Book* average basis prices for certain iron and steel products.*† Steel products are available in such a great variety of qualities and sizes that the quotation of prices and price changes would present difficulties were it not for the device of the basis price and the charging of extras for special qualities. Different basis prices may exist depending on specification (carbon, manganese, etc., content); machining properties (e.g. whether free-cutting); and the particular steel-making process used. A wide range of extras may be chargeable for specified quantities, sizes, special analysis, etc. In some cases there are allowances for quantities in excess of stated limits. Information on all these points can be obtained from the "Deposited Schedules" under the Iron and Steel Price Control Orders.

It will be noted that tinplate prices are not quoted per ton but per basis box. The standard "box" is 112 plates, 20 in. by 14 in., and weighs 108 lb. Tubes are quoted as so much per foot, and it may be noted that 1-in. black gas pipes weigh 1·521 lb. per foot.

46. From time to time the Federation publishes comparisons of the prices of representative steel products in various countries. There are difficulties in the way of such comparisons; for example, Thomas qualities predominate on the Continent, open-hearth quality being subject to extras. The prices shown are for the steels commonly used in each country. In general prices are quoted on the basis of delivery to consumers' station, the calculation in the case of the U.S.A. being based on official estimates of average transport charges for the various products.

British prices were competitive with American prices even before devaluation, being in fact lower for all products, with the exception of alloy steel bars, sheets and tinplate, where U.K. prices were slightly higher. They were also competitive in 1939. Since devaluation British prices have been considerably less for all products.

Capital Expenditure

47. During the 1930's some £50 million was spent on capital projects and capacity was increased from 12 to 14 million ingot tons. In 1946 the Federation's Development plan was published, the total cost of which is now estimated at £240 million and provides for capacity to meet a demand of 18 million ingot tons in the early 1950's. Capital expenditure on the plan has been as follows:

	£ *million*
1946 . . .	16·6
1947 . . .	23·7
1948 . . .	33·2
1949* . . .	45·0
1950* . . .	50·0

* *Economic Survey*, 1950, estimates.

Sources

48. Acknowledgment is due to Mr. L. J. Gollop and the staff of the Economics and Statistics Department of the Federation for their assistance in the preparation of this paper.

The main published sources of information on the industry are given on the following page.

* Lists of current basis prices are published every four weeks in the *Iron and Coal Trades Review*.

† See articles in the *Bulletin*, March, 1949, for further details of recent price changes; a comparison is also made with overseas prices in the *Bulletin* for January, 1950, pp. 10–11.

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(a) BRITISH IRON AND STEEL FEDERATION

The main sources of information are the *Statistical Year Books* and the *Monthly Statistical Bulletins* of the British Iron and Steel Federation. The former comprises three volumes: *U.K. Statistics, Overseas Countries* and a *Tariff Supplement*. The following is a list of articles which have appeared in the *Monthly Bulletin* since January, 1946.

The U.K. Iron and Steel Industry

General

Position of the U.K. Industry	Jan., 1946
Steel Supplies and Exports	Sept., 1946
Current Position of the U.K. Industry	Jan., 1947
Steel and the Export Drive	Nov., 1947
That "Ten Per Cent. More"	Feb., 1948
Where is that "10% More"?	Mar., 1948
Steel's Record Performance	April, 1948
Steel and the Export Targets	May, 1948
A Record Half Year	July, 1948
Steel in the "Economic Survey"	April, 1949
Further Improvement in Steel Supplies	Sept., 1949
The Achievement of 1949 and the Outlook for 1950	Dec., 1949
Steel: The Post-War Record	Mar., 1950
Full Employment and the Steel Industry	April, 1950
Steel Consumption by Industry	July, 1950

Capacity and the Development Plan

Proposed Increase in Capacity	May, 1946
Progress of the Development Plan	May, 1947
Steel-Making Capacity	Sept., 1948
Progress of the Development Plan	Dec., 1948

Prices

Prices and Costs	July, 1946
Steel Prices	Sept., 1947
Iron and Steel Prices	June, 1948
The Advance in Steel Prices	Mar., 1949

Organization

Organization in the Steel Industry	Oct., 1948
The Iron and Steel Bill	Nov., 1948
The Federation and its Work	Jan., 1949
Planning and Competition in Industry	Aug., 1949
The Public Supervision of the Iron and Steel Industry	Oct., 1949

Miscellaneous

War-time Imports of Iron Ore	Feb., 1946
Heavy Steel Products	April, 1946
Fuel Oil in the Steel Industry	Aug., 1947
Prospects for Fuel Oil	April, 1948
Capital Expenditure and the Steel Industry	Dec., 1947
Productivity in the Steel Industry	Aug., 1948
The Steel Age	Feb., 1949
Co-operative Research in the Steel Industry	June, 1949
Training for Steel	Nov., 1949
Fuel Efficiency in the Steel Industry	Feb., 1950

Overseas

General

Production in Other Countries	Jan., 1946
World Iron and Steel Exports	June, 1947
The Marshall Plan	Nov., 1947
Reports of the C.E.E.C. Technical Committees on Iron and Steel and Hard Coke	Dec., 1947 (Suppl.)
Steel Tariff Changes agreed at Geneva	Jan., 1948
A European Steel Programme	May, 1949
Steel Tariff Changes agreed at Annecy	Dec., 1949
European Steel Trends	Jan., 1950
The Interdependence of the European Coal and Steel Industries	May, 1950
European Steel Policies	June, 1950

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Individual Countries

Argentina	June, 1948
Australia	July, 1948
Austria	Mar., 1949
Belgium	April, 1946
Brazil	Nov., 1946
Canada	April, 1947
France	Dec., 1946
„	Dec., 1946 (Suppl.)
Germany	Mar., 1947
„	Mar., 1948 (pp. 8–9)
„	July, 1949
Hungary	Dec., 1948
India	July, 1947
Japan	Aug., 1946
Norway	Sept., 1949
South Africa	Oct., 1946
Sweden	Oct., 1947
U.S.A.	Mar., 1946
U.S.S.R.	June, 1946

(b) OFFICIAL

Committee on Industry and Trade [Balfour Committee]: *Survey of Metal Industries*, Ch. I, 1928.
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(c) OTHER

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The Sources and Nature of Statistical Information in Special Fields of Statistics.

U.K. Tobacco Statistics*

Tobacco statistics are relatively sparse; such figures as are available are published in widely different and not very well known publications, and some of the most useful figures originate abroad. The purpose of these notes is therefore to outline some of the main tobacco statistics which are of interest in the U.K., and to describe the more important difficulties which arise in the use of these figures.

Production of Raw Material, and Particularly of Flue-Cured Tobacco

Tobacco is grown in many countries of the world and in many varieties. The varieties which are of commercial importance vary from country to country with the smoking habits of its public or the nature of its export trade. For practical purposes all tobacco consumed in the U.K. is imported, and the most important varieties are flue-cured, fire-cured and air-cured. Flue-cured tobacco forms about 85 per cent. of the tobacco consumed in this country, as it supplies almost all the content of cigarettes and a large proportion of most pipe tobaccos. It derives its name from the fact that the green leaves are cured and turned to their golden colour by the application of heat, which is applied by conveying hot air through flue-pipes running through the curing barns. Fire-cured tobacco comes from plants which, with a few exceptions, are related to the strains which produce tobacco grown for flue-curing, and the main difference is in the curing process, in which the leaves are exposed to the heat and smoke of fires made from certain hard woods. In this process the colour of the leaves changes from green to a dark mahogany colour. Air-cured tobaccos imported into the U.K. are of a number of different types, of which the main varieties are dark air-cured types, light Oriental types, "burley", and cigar leaf. All these different types of tobacco naturally have their own particular characteristics.

The most comprehensive estimates of world tobacco production are those prepared from time to time by the Office of Foreign Agricultural Relations of the U.S. Department of Agriculture. These figures are based on the official estimates of foreign countries, on estimates made by U.S. Foreign Service Officers, *ad hoc* research and other information. On this basis it was estimated that the total recorded world production of *all* types of tobacco during the 12 months ended June 30th, 1949, was about 7,100 mn. lb. compared with a pre-war annual average of about 6,600 mn. lb. (*Foreign Crops and Markets*, November 14th, 1949, p. 485).† It is the flue-cured type of tobacco, however, which is of greatest concern to the U.K., and it is the lack of large exportable surpluses in this type of tobacco in sterling area countries, to supplement such flue-cured tobacco as can be purchased in U.S.A. and Canada from the dollars available,‡ which has led to the post-war cigarette shortage.

Although the cigarette shortage still exists, the present level of demand for tobacco goods by the British public is considerably less than it was before the April, 1947, Budget, when the standard rate of duty was increased from 35/6*d.* per lb. to 54/10*d.* per lb. (the present rate is 58/2*d.* per lb.). The production for export is also less than demand. If home consumption were allowed to return to its highest post-war level, and if production for export were allowed to expand to meet unfilled demand, the annual supply of flue-cured tobacco required by the U.K. would be about 300 mn. lb. *dry* or *import* weight. On the basis of the present proportions of imported leaf and

* *Note by the Editors*—Although the author of this paper wishes to remain anonymous, it will be clear from its contents that it is written by an authority on the subject.

† [Later note: *Foreign Crops and Markets*, June 5th, 1950, p. 552, contains the following estimates for the world's tobacco harvests: 12 months ended June 30th, 1950, 7,200 mn. lb.; 1949 (revised estimate), 7,400 mn. lb.]

‡ The dollars allocated for the purchase of *all* types of U.S. and Canadian tobacco and the future allocations used for illustrative purposes in the White Paper on *European Co-operation: Memorandum . . . relating to Economic Affairs* . . . 1950–52 (Cmd. 7862, p. 16) are: 1948 crop, $46·8 mn.; 1949 crop, $93·5 mn.; 1950 crop, $68·6 mn.; 1951 crop, $68·6 mn. The foregoing 1948 figure represents only part of the purchase made during 1948. [Later note: The allocations finally fixed, adding together U.S. and Canadian dollars, were: 1948 crop $83 mn.; 1949 crop, $98 mn.; 1950 crop, $97·6 mn.—*v. Financial Times*, September 16th, 1950.]

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strips (i.e. leaf from which the mid-rib has been removed), this is equivalent to about 350 mn. lb. *green* weight (i.e. the weight as sold by the grower).

The quantities of *flue-cured* tobacco produced in recent years in the various countries of the world have been:

TABLE 1

World Production of Flue-cured Tobacco, 12 months ended June 30th

	Average 1936–40	1947	1948	1949	1950 (*preliminary figures*)
	(Million lb. *green* weight)				
Sterling Area:					
Southern Rhodesia	25	58	76	82	106
India	31	59	66	71	70
Union of South Africa	5	20	25	20	22
Nyasaland	3	3	3	3	3
Australia	5	4	2	3	4
New Zealand	1	3	4	5	5
Northern Rhodesia	1	3	4	6	7
	71	150	180	190	217
Other Countries:					
U.S.A.	864	1,352	1,317	1,090	1,112
Canada	55	119	87	102	119
Brazil	..	33	41	39	30
Mexico	1	3	3	2	3
Argentina	1	7	7	6	8
Italy	3	7	12	16	13
China	151	100	143	270	120?
Manchuria	14	15	15	15+	15?
Formosa	3	1	7	7	19
Korea	12	6	13	13	25
Thailand	..	7	7	9	10
Other countries	64	32	42	45	50?
	1,168	1,682	1,694	1,614	1,524
Total	1,239	1,832	1,874	1,804	1,741

Sources.—Foreign Agricultural Circular FT 4–49 issued by the Office of Foreign Agricultural Relations, U.S. Department of Agriculture; and *Foreign Crops and Markets*, March 20th, 1950, p. 234 (both with minor changes).

Principal Pitfalls

(It has been thought that it may be helpful to summarize after each table the principal pitfalls likely to arise in using it, especially as a number of the figures given in this paper have not been previously published. Tobacco statistics inevitably contain many difficulties in interpretation: the "news value" within recent years of developments in the tobacco trade has resulted in articles and comments in the press which have stretched the available statistics to the utmost, and unfortunately provided many illustrations of the difficulties of interpreting accurately such figures as are available.)

(i) The figures are for the 12 months ended June. Tobacco is a highly seasonal crop, and whether the figures fall into one year or another is determined by the date of harvest. Thus, the 1949 figures contain the harvests from July to October, 1948, in north temperate zone countries and the harvests from November, 1948, to June, 1949, for all other countries.

(ii) The figures are in terms of *green* weight.

(iii) It should not be assumed that all the flue-cured tobacco which is grown would meet the taste of the U.K. public. For example, it has been found that flue-cured tobacco grown from certain varieties of seed is not acceptable.

(iv) The figure for "Other Countries" is an omnibus estimate, and covers very minor sterling area producers, such as British East Africa and Mauritius. The 1936–40 figure includes estimates for Brazil and Thailand.

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General Note

In this paper the following symbols have been used:

.. = not available;
— = *nil*, or less than half the final digit shown.

While it might appear that there should be sufficient supplies of flue-cured tobacco available in the world to supply the U.K.'s requirements without difficulty, only a few countries have an exportable quantity of flue-cured tobacco in the varieties and grades suitable for the U.K. over and above their requirements for domestic use; and where such a surplus does exist, there is very keen competition for it between the representatives of a number of importing countries which are all seeking to increase their supplies from non-dollar sources. Thus, there is not only competition between non-growing countries, such as the U.K. and Egypt, for Southern Rhodesian flue-cured tobacco, but this tobacco is also in demand by countries such as South Africa and Australia, which are unable to grow sufficient suitable tobacco to meet their own requirements.

U.K. Purchases and Imports of Flue-Cured Tobacco

The flue-cured crops in countries with an exportable surplus and the amounts which the U.K. is estimated to have purchased from recent crops are as follows:

TABLE 2

Crop Out-turn and U.K. Purchases of Flue-Cured Tobacco from Main Exporting Countries

	Year of Harvest									
	Average 1934–38		1946		1947		1948		1949	
	Crop	*U.K. Purchase*	*Crop*	*U.K. Purchase*	*Crop*	*U.K. Purchase*	*Crop*	*U.K. Purchase*	*Crop*	*U.K. Purchase*
	(Million lb. green weight)									
U.S.A.	786	230	1,352	322	1,317	133	1,090	156	1,112	176
Canada	45	13	119	22	87	12	102	13	119	16
S. Rhodesia	22	17	42	22	58	33	76	49	82	52½
India	27	17	62	14	59	21½	66	28	71	36
Nyasaland	2	1½	3	2	3	2½	3	2	3	2
N. Rhodesia	1	½	3	½	3	½	4	1	6	1
Total	883	279	1,581	382½	1,527	202½	1,341	249	1,393	283½

Source.—Crop figures from official sources in each country: U.K. purchase figures privately estimated.

Principal Pitfalls

(i) The figures are classified by harvest years. Consequently, the 1948 crops in the northern hemisphere are classified as 1948 and not 1949 as in Table 1.

(ii) The figures are in terms of green weight.

(iii) U.K. purchases have been classified according to the year of purchase. In a few exceptional years part of the purchase consisted of tobacco from the previous year's crop.

(iv) Exceptional purchases of negligible amount from certain unimportant sources have been omitted.

(v) The N. Rhodesian crop is grown partly in Eastern N. Rhodesia (4·1 mn. lb. in 1949) and partly in Western N. Rhodesia (1·7 mn. lb. in 1949). At present the former is sold at Fort Jameson, N. Rhodesia, and the latter at Salisbury, S. Rhodesia.

The figures in Tables 1 and 2 are on a *green* weight basis, and represent the weight at which the tobacco is sold by the grower after curing. This weight is only a fraction (about one-fifth)*

* See, for example, H. B. Vickery *et al.*, *Chemical Investigations of the Tobacco Plant*, Carnegie Institution, Washington, p. 11.

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of the weight before curing, and it is perhaps anomalous that the trade should use the term "green weight" to describe the weight of the tobacco after it has been changed by the curing process from its green colour to yellow, orange or brown. (More logically, the U.S. Department of Agriculture uses the term "farm sales weight" instead of green weight, while some other authorities use instead the term "wet weight"). It is necessary to note, however, that the green weight of a quantity of tobacco is higher than its *export* and *import* weights. When sold by the grower the tobacco contains a high degree of moisture, and if this is not immediately removed the tobacco will deteriorate. On purchase, therefore, the tobacco is immediately dried in a handling plant in order to reduce it to a more suitable moisture content, and in consequence, for flue-cured tobacco, the *dry* weight of leaf is about 90 per cent. of the *green* weight.

Before the tobacco undergoes final manufacture into cigarettes, pipe tobacco or cigars, it has to be stemmed or stripped (the words are interchangeable), when the mid-rib of the leaf is removed. This may be done either during the manufacturing process in the U.K., or it may be done in the country of origin before the tobacco is dried in the buyer's handling plant. Formerly, a considerable amount of the tobacco imported into the U.K. arrived in stripped form, but the amount stripped in the country of origin is now greatly reduced—for example, in order to conserve dollars this practice has been almost entirely discontinued for U.S. and Canadian purchases. The dry weight after stemming forms 75–80 per cent. of the dry weight of the unstemmed leaf, so that the ratio of *export* weight (and therefore of U.K. *import* weight) to the *green* weight varies with the proportion of tobacco which is exported in the form of strips.

Tobacco is a highly seasonal crop. Each crop is marketed, shipped and imported into the U.K. during a few months of the year only. The harvest and marketing seasons tend to vary according to the hemisphere, tobacco grown in the northern hemisphere usually being harvested and marketed during the second half of the year (India is an exception), while tobacco grown in the southern hemisphere is normally harvested during the first half of the year and marketed from April to September. This seasonal characteristic requires careful watching when statistics for different years are being compared. As was pointed out in the footnotes to Tables 1 and 2, the U.S. and Canadian 1948 crops, for example, were given in the column headed 1948 in Table 2 and in the column headed 1949 in Table 1.

The effect of the limited shipment and import periods requires corresponding care in interpreting import statistics. If, for various reasons, there are delays in the shipment of the U.S. flue-cured crop, a larger proportion will arrive in the calendar year following the calendar year in which the crop was marketed than would otherwise have occurred. Consequently, import statistics compiled on a calendar year basis give no indication of the tobacco which has been purchased from the crop of any particular year, and it is therefore most misleading to compare the imports of one calendar year with those of the preceding calendar year if it is desired to find out how the purchases from one crop compare with those from the previous crop. The following table (Table 3) sets out the marketing, shipment and U.K. importing periods respectively for the main crops.

It is, of course, even more misleading to compare the imports during one month or a number of months of a year with those of the corresponding period of the previous year. Such comparisons are vitiated by variations in the promptness with which the tobacco is shipped and by variations from year to year in the proportions shipped as leaf and strips respectively. The best means of obtaining an accurate picture of the tobacco purchased in one year for comparison with the tobacco purchased in a previous year is to use the figures for the U.K. purchase, such as those given in Table 2. These figures, however, are not officially published, although popular estimates are naturally available on the markets concerned during the period of marketing. If these estimates cannot be obtained, the best substitute for them is to use the figures of imports of tobacco, distinguishing leaf and strips, *on a suitable import year basis* as opposed to a calendar year basis.

The most suitable 12-monthly period for imports of tobacco from northern hemisphere countries is the year ended June 30th, and for tobacco from southern hemisphere countries the year ended March 31st; for combined imports the most suitable period is the year ended June 30th. Monthly figures of imports of flue-cured and other types of tobacco, distinguishing leaf and strips and countries of consignment, can be obtained from the recently resuscitated and very useful *Tobacco Intelligence* and its monthly supplement, *Tobacco Bulletin*, published by the

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TABLE 3

Marketing, Shipment and U.K. Import Periods for Various Types of Tobacco from the Main Exporting Countries

Country of Origin	*Type of Tobacco*	*Marketing Period*	*Shipment Period*	*U.K. Import Period**
United States	Flue-cured	Late July–January	August–February	September–April
	Burley	December–February	January–March	February–April
	Dark fire-cured	,, –March	,, ,,	,, ,,
	,, air-cured	,, ,,	,, ,,	,, ,,
Canada	Flue-cured	November	November–April	December–May
	Burley	,,	December–April	January–May
	Dark fire-cured	,,	,, ,,	,, ,,
S. Rhodesia	Flue-cured	April–October	May–January	July–April
	Oriental	August	April	May
Nyasaland	Flue-cured	April–September	May–December	August–March
	Dark fire-cured	,, ,,	,, –January	,, –April
	Sun-cured	May– ,,	,, –December	June–January
India	Flue-cured	Late January–April	April–November	June–February
	Dark air-cured	March–August	May–December	November–April
Turkey	Oriental	October–December	January–April	January–April
Greece	Oriental	October–December	January–April	February–April

* Refers to the period when the bulk of the purchases destined for U.K. may be expected to arrive.

Commonwealth Economic Committee. The monthly Trade and Navigation Accounts, published by the Customs and Excise, give statistics of the flue-cured and other types of tobacco imported each month in total, but do not distinguish leaf and strips or the country of consignment.

The following tables (Tables 4 and 5) show respectively the imports of all types of unmanufactured tobacco and of flue-cured tobacco during recent import years:

TABLE 4

U.K. Imports of Unmanufactured Tobacco by Countries of Consignment

		Years ending June 30th			
		Average 1934–38	1947	1948	1949
		(Million lb. dry weight)			
Southern Rhodesia	Stripped	1·5	7·5	11·4	12·2
	Unstripped	12·7	11·4	20·5	27·9
Nyasaland	Stripped	3·8	4·8	7·2	6·0
	Unstripped	8·1	5·4	7·0	8·9
India	Stripped	14·4	17·9	21·0	29·1
	Unstripped	2·0	1·0	0·8	3·3
Canada	Stripped	0·8	0·4	0·5	0·1
	Unstripped	9·3	20·0	12·6	12·6
Other British countries	Stripped	0·3	0·2	0·4	0·5
	Unstripped	1·2	1·6	1·5	4·0
U.S.A.	Stripped	28·3	27·9	10·9	3·1
	Unstripped	170·6	253·0	119·9	144·1
Turkey	Stripped	—	—	—	—
	Unstripped	..	2·0	1·2	25·4
Other foreign countries	Stripped	0·2	—	—	—
	Unstripped	4·2	12·0	0·6	7·1
Total	Stripped	49·3	58·7	51·4	51·0
	Unstripped	208·1	306·4	164·1	233·3
Total		257·4	365·1	215·5	284·3
Whereof: *Flue-Cured Tobacco*		188·9	326·2	192·3	224·2

Source.—Monthly Trade and Navigation Accounts.

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Principal Pitfalls

(i) When analysed, the "other countries" will be found to include some countries which only re-export the tobacco as part of their entrepôt trade and which are not the original country of origin.

(ii) Prior to 1943 the *monthly* imports of *flue-cured* tobacco were merged in the total for *light* tobaccos, which included Oriental leaf (primarily from Greece, Turkey and Cyprus), air-cured leaf from India and cigar leaf from Burma. The pre-war imports of these latter types were generally small. The Annual Statement of Trade changed the classification from *light* tobaccos to *flue-cured* in 1939.

(iii) Imports of Turkish tobacco were included in "Other Foreign Countries" in the Monthly Trade and Navigation Accounts before the war. Details cannot therefore be provided for the years ended June 30th before the war. The Annual Statement of Trade, however, does give figures of imports of Turkish tobacco on a calendar year basis. These imports amounted to 1·6 mn. lb. in 1937 and 0·4 mn. lb. in 1938.

TABLE 5

U.K. Imports of Flue-Cured Tobacco by Countries of Consignment
(*Years ending June 30th*)

	1948			1949		
	Unstripped	*Stripped*	*Total*	*Unstripped*	*Stripped*	*Total*
	(Thousand lb. dry weight)					
S. Rhodesia	20,063	11,232	31,295	26,907	11,980	38,887
India	661	15,685	16,346	2,757	22,079	24,836
Canada	11,727	403	12,130	11,290	42	11,332
Nyasaland	1,935	795	2,730	1,608	909	2,517
N. Rhodesia	624	79	703	845	127	972
Union of S. Africa	—	—	—	1,503	—	1,503
Tanganyika	103	1	104	392	42	434
Hong Kong	—	—	—	48	—	48
Cyprus	24	2	26	—	—	—
Uganda	—	—	—	20	—	20
U.S.A.	118,143	10,814	128,957	140,635	2,445	143,080
Hungary	—	—	—	269	—	269
Italy	—	—	—	221	—	221
Norway	—	—	—	53	—	53
Netherlands	41	—	41	—	—	—
Turkey	—	—	—	25	—	25
Brazil	—	—	—	10	—	10
Total	153,321	39,011	192,332	186,583	37,624	224,207

Source.—Commonwealth Economic Committee Secretariat. Details in the above form are not available for earlier years. [Later note: Later figures, including small revisions for 1948, will be found in *Tobacco Intelligence*, August 1950, p. 4.]

Principal Pitfalls

(i) The N. Rhodesian figures in Table 5 appear to represent—as tobacco statisticians would actually prefer—the quantities which are of N. Rhodesian origin rather than the quantities directly consigned from N. Rhodesia. The Western N. Rhodesian tobacco which is sold in S. Rhodesia (see Pitfall (v) of Table 2) is consigned from S. Rhodesia, but on entry into the U.K. is declared to be of N. Rhodesian origin: at least part of the Eastern N. Rhodesian tobacco, after sale in N. Rhodesia, is redried in Nyasaland and consigned to the U.K. from there, but is also on entry declared to be of N. Rhodesian origin. The accurate declaration of the country of origin of Commonwealth tobacco is necessary in order to comply with the regulations for the preferential rate of duty.

(ii) On the other hand, the imports consigned from Hong Kong, Norway and the Netherlands represent re-exports from these countries, presumably of non-Commonwealth tobacco.

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The purchases of flue-cured tobacco on a harvest year basis and the imports on an import year basis therefore line up as follows:

TABLE 6

U.K. Purchases (green weight) and U.K. Imports (dry weight) of Flue-Cured Tobacco

Crop	*Purchase Weights* (Million lb. *green* weight)	12 *months ended June 30th*	*Import Weights* (Million lb. *dry* weight)
1946	382	1947	326
1947	202	1948	192
1948	249	1949	224

[Later note: The weight purchased from the 1949 crops was 283½ mn. lb. (Table 2 above); the weight imported during the 12 months ended June 30th, 1950, was 264 mn. lb. (*Tobacco Intelligence*, August, 1950, p. 4.)]

Principal Pitfalls

(i) The import figures cover leaf and strips combined.

(ii) The crop years covered have to be interpreted with care, as the import figures for each year mentioned cover the crops harvested during the previous year in both northern and southern hemisphere growing countries. Thus, the import figures for the 12 months ended June 30th, 1949, cover all the 1948 crops.

To illustrate the misleading nature of calendar year imports of tobacco as a guide to the size of purchase from a crop, it may be added that the calendar year figures for imports of flue-cured tobacco, as they have been published in the *Annual Statement of Trade*, are:

TABLE 7

Imports of Flue-Cured Tobacco on a Calendar Year Basis

Calendar Year	*Import Weights* (Million lb. dry weight)		
	Leaf	*Strips*	*Total*
1946	353	54	407
1947	213	43	256

It will be seen, therefore, that calendar year figures are of little guide to the size of purchase from a crop.

U.K. Stocks of Unmanufactured Tobacco

Since tobacco imports are highly seasonal, the stocks in bonded warehouses in this country have a considerable seasonal movement. The seasonal movement in total stocks reflects the aggregate effect of the different importing periods of the various types of tobacco and of a seasonal movement in production, which is mentioned below. Figures of tobacco stocks in bond are published in the *Monthly Trade and Navigation Accounts* (Bonded Warehouse Account), and reproduced in the *Monthly Digest of Statistics* of the Central Statistical Office. These figures are for total stocks only; separate figures for flue-cured stocks are not published. The figures of total stocks for a recent period are set out in Table 8.

As will be seen, aggregate tobacco stocks normally reach their lowest about July, before the first shipments from the new crops start to arrive in volume. Before the war, manufacturers aimed at having about 24 months' stock of any particular type of tobacco at the time of year the stocks of that type were normally lowest. Owing to the unrefilled drain which manufacturers had to make on their stocks during and after the war, current stocks are very much lower than pre-war stocks. The reasons for aiming at longer stocks were, of course, to enable the quality

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of the product to benefit by maturing the tobacco in bond for a longer period, to insure against short crops, and to enable the varying qualities of successive crops of the same type of tobacco to be blended together so as to maintain uniform quality in the manufactured product. Not only are current stocks very much lower than pre-war stocks, but within any particular type of tobacco, the stocks of individual grades will vary considerably from the average duration for that type, and stocks of some grades may be considerably lower than the average. As stocks fall, it naturally becomes more difficult for manufacturers to maintain uniformity in the quality of their product.

U.K. Usings of Unmanufactured Tobacco

Stocks should, of course, be considered in relation to usings of tobacco in manufacture for home and export. From the point of view of Customs and Excise statistics, however, tobacco factories fall into two different classes—excise factories and bonded factories. Tobacco used for manufacture in excise factories is cleared from bond on payment of the necessary duty before manufacture, and drawback is subsequently claimed on any goods manufactured in excise factories which are exported or supplied as ships' stores, etc., and on any unusable stalks, tobacco shorts or offal which are sold for nicotine extraction or abandoned. Duty is paid on tobacco which is manufactured in bonded factories only if and when the final product is cleared for home consumption: tobacco goods which are made in bond and exported or supplied as ships' stores, etc., remain duty free. Tobacco manufactured in bond is sometimes termed "cavendish" or "negrohead". These terms, however, are frequently used with more than one meaning, and a brief note on them is appended at the end.

Statistics of the foregoing categories of tobacco are published on varying bases by the Customs and Excise. Details are published each month, in the Home Consumption Account of the *Trade and Navigation Accounts*, of unmanufactured tobacco cleared for manufacture in excise factories (known generally as *gross* clearances of *unmanufactured* tobacco for home and export manufacture), of manufactured goods made in excise factories on which drawback has been paid, of stalks, shorts and offal deposited by excise factories for drawback, and of manufactured tobacco goods made in bond or imported which are cleared for home consumption. The total clearances of unmanufactured plus manufactured tobacco for home consumption less manufactured goods and unusable tobacco deposited for drawback are known as *net* clearances for home consumption.

The unmanufactured tobacco used each month by tobacco manufacturers therefore consists of the gross clearances for home and export manufacture into excise factories plus deliveries to bonded factories. Figures of deliveries of unmanufactured tobacco to bonded factories are not available, but a reasonably satisfactory substitute would be the manufactured weight of tobacco goods made in bond and cleared for home consumption, exported or supplied as ships' stores, etc. As already mentioned, figures of tobacco goods made in bond and cleared for home consumption are published monthly, but the only figures published for exports from bonded factories are for sweetened smoking tobaccos—publication of the figures for exports of cigarettes made in bond was discontinued in 1934, when the figures were merged with those of exports of cigarettes made in excise factories. Figures of tobacco goods made in bond and supplied as ships' stores, etc., are published on a calendar year basis only after being merged with the figures of imported tobacco goods supplied as ships' stores, etc., in the *Annual Statement of the Trade of the U.K.* (Vol. IV—Supplemental Bonded Warehouse Account), and while figures of tobacco goods made in bond and supplied as ships' stores, etc., are published separately in the *Annual Report of the Commissioners of Customs and Excise*, unfortunately, like all the figures in this Report, they are given only for the 12 months ended March 31st, and so are not comparable with the calendar year series of other statistics.* (The phrase "ships' stores, etc." covers goods deposited in bond

* There is no doubt that a very valuable contribution to tobacco statistics would be made if the Commissioners of Customs and Excise would publish or otherwise make available on a calendar year basis the tobacco statistics contained in their Annual Report. It is appreciated, of course, that the accounting system of the Customs and Excise is geared to the financial year, as all revenue figures have to be produced on this basis, and that to give the figures also on a calendar year basis would, if otherwise practicable, involve a certain amount of extra work. (A few of the revenue figures are, of course, available after much delay on a calendar year basis—see, for example, Vol. II (Supplement) of the *Annual Statement of the Trade of the U.K.*, 1947, pp. 81–2).

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or H.M. victualling stores for duty-free supply to merchant vessels and the Navy and Army.)

It is therefore impossible to determine exactly from the published statistics what the total usings of unmanufactured tobacco in the U.K. are.* Fortunately, however, it is known that the bulk of tobacco goods are made in excise factories, and that the proportion made in bonded factories amounts at the most to no more than about 2 per cent. of the total U.K. production. Consequently, gross clearances of unmanufactured tobacco for home and export manufacture in excise factories may, without serious inaccuracy, be taken as representing the usings of tobacco, provided that it is borne in mind that there is this small element of understatement. (Figures of usings of unmanufactured tobacco by excise and bonded factories respectively may be available for 1948, but only as the aggregate of varying financial years, when the 1948 *Census of Production* figures are published.)

Figures of bonded stocks, of gross clearances of unmanufactured tobacco for home and export manufacture by excise factories, and of the approximate duration of bonded stocks month by month are set out in Table 8.

TABLE 8

Month	*Stocks in Bonded Warehouses at Month's End*				*Gross Clearances of Unmanufactured Tobacco for Home and Export Manufacture by Excise Factories*				*Stock Duration in Months*			
	1938	1947	1948	1949	1938	1947	1948	1949	1938	1947	1948	1949
	(Million lb.)				(Million lb.)							
January	520·1	384·7	375·1	391·3	20·2	30·1	24·0	23·5	25·7	12·8	15·6	16·7
February	518·4	390·4	370·5	384·9	19·5	22·1	21·4	21·5	26·6	17·7	17·3	17·9
March	522·5	390·5	361·5	370·0	23·6	28·9	23·2	24·0	22·1	13·5	15·6	15·4
April	518·5	394·0	348·1	357·3	18·4	25·8	23·0	21·1	28·2	15·3	15·1	16·9
May	507·5	392·6	330·4	339·1	22·5	24·4	21·7	24·9	22·6	16·1	15·2	13·6
June	497·7	377·3	314·0	324·7	20·8	22·4	24·1	22·2	23·9	16·8	13·0	14·6
July	490·2	364·9	329·9	321·7	20·1	22·7	20·3	19·9	24·4	16·1	16·3	16·2
August	493·0	354·7	344·3	321·8	20·3	20·7	21·4	21·9	24·3	17·1	16·1	14·7
September	516·4	352·2	369·1	352·9	22·4	24·3	23·0	23·1	23·1	14·5	16·0	15·3
October	552·2	373·6	383·0	392·2	22·0	26·7	22·9	23·1	25·1	14·0	16·7	17·0
November	570·4	384·1	388·5	408·8	23·3	22·5	24·6	25·1	24·5	17·1	15·8	16·3
December	582·7	383·7	390·1	420·7	19·9	21·7	22·1	21·0	29·3	17·7	17·7	20·0

Principal Pitfalls

(i) *Gross* clearances do not cover tobacco used in bonded factories, and consequently, as mentioned in the text, slightly under-state total usings and over-state stock durations.

(ii) The figures of stocks cover all types of tobacco, and different types reach their lowest level at different months of the year. Consequently, the stock duration of each type, at its lowest, falls below the figures actually shown, since the general average duration of all types is brought up by the higher stocks, at that month, of other types of tobacco.

It is particularly important to note that it is *gross* clearances of unmanufactured tobacco which should thus be compared with stocks, and not *net* clearances (i.e. gross clearances of manufactured and unmanufactured tobacco less deposits for drawback).

The amount of leaf which a manufacturer could clear for manufacture *for the home market* was limited by quota from August 1st, 1940, to April 30th, 1950. (The export trade was not subject to quota, but the U.K. dollar allocation for the purchase of leaf included an allocation for export manufacture.) The quota levels as a percentage of the base year (which was the 12 months ended March 31st, 1940) and the equivalent maximum permitted monthly clearances were as follows:

* An alternative approximation to the usings for any period may be obtained by taking bonded stocks of unmanufactured tobacco at the start of the period, adding imports and deducting stocks at the end of the period, and unmanufactured tobacco re-exported or delivered to ships' stores or H.M. victualling yards during the period. But—for various technical reasons—the resulting figure is still only an approximation.

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TABLE 9

Restriction of Home Clearances

Period	Quota Percentage	
	For Total Clearances	*For Clearances of Tobacco bearing Duty at Full Rate*
Aug., 1940–Mar., 1941 . . .	90	90
Apr., 1941– ,, 1942 . . .	108	108
,, 1942–May, 1942 . . .	108	95
June, 1942–Sept., 1942 . . .	108	90
Oct., 1942–Jan., 1943 . . .	108	95
Feb., 1943–May, 1943 . . .	108	100
June, 1943– ,, 1945 . . .	108	108
,, 1945–Sept., 1945 . . .	113	113
Oct., 1945–July, 1946 . . .	115	115
Aug., 1946–June, 1948 . . .	120	120
July, 1948–Apr., 1950 . . .	100	100

Principal Pitfalls

(i) The figures cover home trade only. The quota was expressed in terms of a total quota, within which a further quota was fixed for tobacco bearing duty at the full rate. For some months during the war the percentage quota for "full rate" tobacco was lower than the percentage quota for total tobacco, and during this period the difference could, of course, be made up by clearing additional "other rate" tobacco.

(ii) Subsequently, Oriental types of tobacco were placed outside quota, Non-Commonwealth Oriental tobacco being so classified from September 1st, 1948, and Commonwealth Oriental tobacco from November 1st, 1948.

(iii) Owing to the shortage of leaf stocks the full quota could not always be cleared. During the latter part of 1949, for example, clearances for the home market of tobaccos on quota averaged only about 95 per cent. of quota.

(iv) The abolition of clearance quotas from April 30th, 1950, did not result in any increase in supply of manufactured tobacco to the home market, as manufacturers' usings continued to be limited by their leaf stocks and prospective supplies. Moreover, American, Canadian and Southern Rhodesian tobaccos continued to be subject to official limitation—American and Canadian tobaccos through the control of dollar allocations and Southern Rhodesian through import licences.

Manufacture of Tobacco Goods

Reliable figures for the production of manufactured tobacco goods do not exist. Figures obtained in the 1907, 1912, 1924, 1930 and 1935 Censuses of Production have, of course, been published. Even apart, however, from certain features of the pre-war Censuses which add to the difficulties of those using published tobacco statistics—as, for example, the inclusion in 1935 and in the back figures then published for 1930 of the weight of cigarette paper, cork tips, filter plugs, etc., in the weight of cigarettes, and the grouping together of all kinds of sweetened tobacco, sweetened cigarettes, etc., under the category of cavendish and negrohead—there have been variations in the coverage of the figures published in the Census reports for the tobacco trade, which are somewhat confusing at first, and which must be borne in mind when comparing the figures of different Censuses or when comparing Census totals with national aggregates published elsewhere. The coverage of tobacco figures in the published reports of past Censuses has been as follows:

1907—Great Britain and Ireland.

1912—Great Britain only. (The 1912 figures were published in the 1924 Report, this Report containing back figures for 1912 and 1907 on a Great Britain only basis.)

1924—Great Britain only. (The Northern Ireland tobacco figures were included in the figures for Spirit Distilling and Brewing and Malting trades.)

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1930—Same as 1924.

1935—Great Britain and Northern Ireland, but with back figures for Great Britain and Northern Ireland in respect of 1930 and (for some tables), 1924.

The 1948 Census covered Great Britain only, Northern Ireland being excluded.

Apart from these particular difficulties, the published Census figures cover only five specific years, so that any attempt to arrive at figures for the production or out-turn of tobacco factories has to build up the required data from figures of home sales, exports and supplies to ships' stores, etc. Figures for home sales of tobacco goods for the years 1920–38 were published by J. R. N. Stone in his article on "Analysis of Market Demand",* and those for later years are to be found in the annual White Paper on National Income. The figures for exports and supplies to ships' stores, etc., are more difficult to obtain on the required basis. As for other trades, the Customs and Excise publish the usual figures for exports on a monthly and annual basis, but both sets of figures exclude supplies to ships' stores, etc. On the other hand, as already mentioned, the Customs and Excise publish monthly figures of tobacco goods deposited for drawback, but these figures naturally exclude the export and ships' stores trade of bonded factories. (The goods which are eligible for drawback consist of goods made in excise factories which are either exported or supplied as ships' stores, etc., and stalks and tobacco shorts and offal which, being waste material arising in manufacture, are abandoned to the Customs or sold for nicotine extraction. A limit of 6 per cent. on deposits of stalk and offal for drawback was introduced from November, 1942 (except for cigar leaf) and is still in force. The limit on deposits of tobacco other than flue-cured tobacco, however, was raised to 10 per cent. from July 1st, 1949. As deposits of stalk and offal averaged about 12 per cent. pre-war, this means that the current ratio of gross clearance weight to manufactured weight differs from the pre-war ratio. Imported manufactured goods are not eligible for drawback.)

The respective coverage of the monthly figures of manufactured tobacco goods exported or deposited for drawback, published in the *Trade and Navigation Accounts* by H.M. Customs and Excise, may be summarized as follows:

	Monthly Export Figures	*Monthly Drawback Figures*
Goods made in excise factories:		
Exports	Included	Included
Ships' stores, etc.	Excluded	,,
Supplies to N.A.A.F.I. for H.M. Forces abroad	Included	,,
Goods made in bonded factories:		
Exports	Included	Excluded
Ships' stores, etc.	Excluded	,,
Supplies to N.A.A.F.I. for H.M. Forces abroad	Included	,,

In theory, therefore, there are two methods of building up manufactured tobacco out-turn, namely:

First Method

1. Goods made in excise or bonded factories, *and* sold for home consumption.
2. Goods made in excise factories on which drawback has been claimed.
3. Goods manufactured in bonded factories *and* exported or supplied to ships' stores, etc.

Second Method

1. As in the First Method.
2. Exports of goods made in the U.K.
3. Supplies to ships' stores, etc., of goods made in the U.K.

Unfortunately the second approach is not possible in practice because items 2 and 3, up to June, 1946, *both* include tobacco shipped by N.A.A.F.I. for the use of forces abroad, and this duplication appears in some years to amount to over 25 per cent. of the total. Nor is the first

* *J.R. Statist. Soc.*, 1945, p. 339.

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TABLE 10

Details of U.K. Production of Tobacco Goods

Calendar Year	Sales of U.K.-made Tobacco Goods to the Home Distributive Trade				Manufactured Tobacco Deposited for Drawback				Exports of Goods made in Bond		Total U.K. Production of Tobacco Goods			
	Cigarettes	Pipe Tobacco	Cigars and Snuff	Total	Cigarettes	Cut Roll or Cake	Cigars and Snuff	Total	Cigarettes	Sweetened Pipe Tobacco	Cigarettes	Pipe Tobacco	Cigars and Snuff	Total
	(Million lb. manufactured weight)													
1920	77·0	64·0	2·0	143·0	5·3	0·7	0·1	6·1	12·1	3·7	94·4	68·4	2·1	164·9
1	75·0	63·5	2·0	140·5	2·0	0·3	—	2·3	7·6	1·7	84·6	65·5	2·0	152·1
2	72·0	62·0	2·0	136·0	2·1	0·3	—	2·4	9·7	2·8	83·8	65·1	2·0	150·9
3	72·0	58·0	2·0	132·0	3·8	0·4	0·1	4·3	10·6	3·1	86·4	61·5	2·1	150·0
4	75·0	58·0	2·0	135·0	4·1	0·5	0·1	4·7	11·0	2·7	90·1	61·2	2·1	153·4
1925	80·0	58·0	2·0	140·0	4·4	0·4	0·1	4·9	12·3	3·0	96·7	61·4	2·1	160·2
6	83·0	56·0	2·0	141·0	6·0	0·4	0·1	6·5	14·1	2·8	103·1	59·2	2·1	164·4
7	89·0	55·0	2·0	146·0	11·6	0·4	0·1	12·1	10·2	2·4	110·8	57·8	2·1	170·7
8	95·4	54·7	1·8	151·9	22·6	0·5	0·1	23·3	4·5	2·0	122·5	57·2	1·9	181·6
9	101·2	53·2	1·8	156·2	31·0	0·6	0·1	31·7	2·7	1·7	134·9	55·5	1·9	192·3
1930	106·9	51·4	1·8	160·1	30·6	0·5	—	31·1	1·3	1·5	138·8	53·4	1·8	194.0
1	108·6	49·7	1·8	160·1	20·4	0·5	—	20·9	—	1·0	129·0	51·2	1·8	182·0
2	109·2	47·1	1·7	158·0	16·4	0·6	—	17·0	—	0·9	125·6	48·6	1·7	175·9
3	114·5	45·5	1·7	161·7	17·2	4·3	—	21·5	—	0·9	131·7	50·7	1·7	184·1
4	118·8	45·8	1·8	166·4	19·8	7·2	—	27·0	..	0·7	138·6	53·7	1·8	194·1
1935	126·7	45·0	1·9	173·6	23·0	6·1	—	29·1	..	0·7	149·7	51·8	1·9	203·4
6	137·1	44·2	1·9	183·2	24·1	5·0	—	29·1	..	0·6	161·2	49·8	1·9	212·9
7	147·9	43·1	2·0	193·0	28·1	6·9	—	35·0	..	0·7	176·0	50·7	2·0	228·7
8	154·8	42·6	2·0	199·4	26·6	6·6	—	33·2	..	0·6	181·4	49·8	2·0	233·2
9	162·6	41·5	1·8	205·9	28·0	8·9	—	36·9	..	0·7	190·6	51·1	1·8	243·5
1940	160·8	40·0	1·6	202·4	30·8	6·0	—	36·8	..	0·5	191·6	46·5	1·6	239·7
1	179·5	42·8	2·0	224·3	29·6	2·5	0·1	32·2	..	0·8	209·1	46·1	2·1	257·3
2	193·9	45·4	2·1	241·4	24·6	2·9	—	27·5	..	0·6	218·5	48·9	2·1	269·5
3	190·2	39·1	2·0	231·3	35·1	4·8	—	39·9	..	0·6	225·3	44·5	2·0	271·8
4	188·0	37·2	1·9	227·1	54·9	6·0	—	60·9	..	0·4	242·9	43·6	1·9	288·4
1945	201·2	38·3	1·8	241·3	64·3	4·8	—	69·0	..	1·7	265·5	44·8	1·8	312·1
6	220·5	41·3	1·5	263·3	52·8	4·6	—	57·4	..	2·1	273·3	48·0	1·5	322·8
7	195·0	37·9	1·5	234·4	51·6	2·1	—	53·7	..	0·9	246·6	40·9	1·5	289·0
8	181·4	41·0	1·5	223·9	44·6	2·1	—	46·7	..	0·9	226·0	44·0	1·5	271·5
9	179·6	41·5	1·3	222·4	46·7	1·7	—	48·4	..	0·8	226·3	44·0	1·3	271·6

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method entirely satisfactory, as details of the disposition of goods made in bond are not published in full on a calendar year basis by the Customs and Excise—the publication separately of figures of exports of cigarettes made in bond was discontinued from 1934, while figures of supplies to ships' stores, etc., of tobacco made in bond are not available separately and, as mentioned above, are published only in a combined total with imported manufactured tobacco similarly supplied as ships' stores, etc. The amounts omitted by neglecting exports of cigarettes made in bond and supplies to ships' stores, etc., of all tobacco goods made in bond, however, are relatively small, and the aggregates which are built up even if these two items are excluded should, apart from other errors, not under-state the true total by more than 2 per cent. at the most. The resulting figures are given in Table 10.

Principal Pitfalls

(i) Production figures exclude ships' stores supplied from bonded manufacture throughout the period, and exports of cigarettes manufactured in bond from 1934 onwards.

(ii) Sweetened pipe tobacco made in the U.K. and entered for Home Consumption is included in the figure of Home Sales to the Distributive Trade.

A more important source of error, however, is the omission to adjust the totals for variations in manufacturers' packed stocks in order to arrive at actual production, but figures of packed stocks are naturally not available. There is a considerable amount of seasonal variation in cigarette production, where stocks are built up during the winter months and drawn upon in summer. There is even more seasonal variation in cigar production, where stocks are built up during the year for the Christmas trade (in so far as the cost of financing duty-paid manufactured stocks permits). While seasonal variation fortunately becomes of less importance in considering annual figures on a calendar year basis, it is by no means entirely unimportant, since the rate and extent of cigarette stock build-up varies from one winter to the next.

A component for tobacco production is included in both the Central Statistical Office and London and Cambridge Economic Service indices of production, but in both indices the tobacco component is based on gross clearances for home and export. This figure is naturally not entirely accurate: in particular, it ignores variations in stocks of cleared but unmanufactured leaf and variations in work in progress, both of which can be quite substantial from month to month.

Numbers Employed in Tobacco Manufacture

The numbers employed in tobacco manufacture in Great Britain and Northern Ireland at mid-1949 and mid-1948 were approximately as follows:

TABLE 11

Employees in Tobacco Manufacture (in thousands)

	June 25th, 1949	*June 26th,* 1948
Males	21·3	21·4
Females—Full-time	27·1	27·8
,, —Part-time	3·5	3·7
,, —Total	30·6	31·5
Total	51·9	52·9

Source.—Based mainly on figures published in the *Ministry of Labour Gazette.*

Principal Pitfalls

(i) Figures cover Great Britain and Northern Ireland: not G.B. alone.
(ii) Figures are of insured persons in employment: not total insured.
(iii) Part-time employees are counted as 1 and not as ½.

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An analysis of the total employees in Great Britain (i.e. excluding Northern Ireland) between operatives and administrative, technical and clerical employees should be available from the Census of Production figures.* These figures, however, will not distinguish between full-time and part-time employees, but it may be assumed that all part-time employees were operatives.

There was a discrepancy between the employment figures for the tobacco industry given in the 1924, 1930 and 1935 Census of Production reports and those published by the Ministry of Labour. While the Ministry of Labour figures were compiled on a varying basis, owing to changes from time to time in the insurance coverage, yet even when the Ministry figures are adjusted to a constant and comparable basis and allowance is made (1) for employees not covered by the Census (e.g. employed in merchanting or excluded for other reasons), (2) for the inclusion in the Ministry of Labour figures and exclusion from the Census figures of employees in ancillary departments such as box-making, and (3) for differences in the dates for which the figures are estimated, the employment figures for the tobacco industry given by the Census and those published by the Ministry of Labour still do not agree.

Sales to the Public

The quantities and retail values of tobacco goods sold to the public, together with the revenue collected from the duty on these goods, since 1920 are estimated to have been as shown in Table 12.

Principal Pitfalls

(i) The above figures are estimated sales to the public; sales to the distributive trade are given in Table 10. For the years before 1936, the figures of the two series are the same, as reasonably reliable estimates could not be made of changes in distributors' stocks.

(ii) The figures cover Great Britain and Northern Ireland, Southern Ireland being excluded throughout. For 1927 and previous years sales have been estimated to the nearest million lb. weight. For subsequent years estimates are to the nearest 100,000 lb.

(iii) Imported manufactured goods and duty-free supplies to Naval Shore Establishments in the United Kingdom are not included in the figures.

(iv) Sweetened tobaccos manufactured in bond for home consumption are included in the figures.

(v) The sales of cigarettes are given in the above table in weight. Those who wish to convert them to a count basis may find suitable conversion factors in Shirras and Rostas, *The Burden of British Taxation*, p. 129, or in Rostas, *Comparative Productivity in British and American Industry*, p. 202.

(vi) *Sales at concession prices.*—While allowance has been made for sales by N.A.A.F.I. at pre-April, 1942, Budget prices up to April, 1947, when the privilege ceased, no allowance has been made for the price concession made to Old Age Pensioners, which came into effect in October, 1947.

(vii) The revenue collected from tobacco duties represents the duty on clearances for home consumption of unmanufactured leaf and manufactured goods made in bond. To obtain the net revenue, the cost of relief to old age pensioners should be deducted from the 1947 figures (£1·1 mn. for the calendar year 1947).

It is perhaps worth mentioning that the index of retail tobacco sales published by the Board of Trade has not provided an accurate index of the sales of tobacco goods. For example, the 1950 White Paper on *National Income*† showed that consumer expenditure on tobacco goods was 1·2 per cent. lower in 1949 than in 1948, but according to the Board of Trade Index, retail sales of tobacco and tobacconists' goods were over 2½ per cent. higher in 1949 than in 1948. The month to month variations and the regional changes suggested by the Board of Trade index are even less reliable. The difficulty with which the Board of Trade has to contend is that the sample upon which their tobacco figures are based is a voluntary sample consisting mainly of multiple tobacconists and co-operative societies. Some department stores are also included in the Board

* [Later note: See *Board of Trade Journal*, June 10th, 1950, p. 1208.]

† Cmd. 7933, p. 28. Cf. also the *Economic Survey for 1950* (Cmd.7915), p. 34.

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TABLE 12

Sales and Retail Values of Tobacco Goods Sold to the Public and Revenue from the Sales of these Products
(G.B. and N.I. throughout)

Year ended December	Sales of Tobacco Goods to the Public					Retail Values of Tobacco Goods sold to the Public			Revenue Collected from Tobacco Duties on these types of Goods
	Cigarettes	Tobaccos	Cigars	Snuff	Total	Cigarettes	Pipe Tobaccos, Cigars and Snuff	Total	
	(Million lb. manufactured weight)					(£ million)			(£ million)
1920	77·0	64·0	2		143·0	74·9	40·9	115·8	55·8
1	75·0	63·5	2		140·5	72·4	40·6	113·0	56·3
2	72·0	62·0	2		136·0	68·5	39·7	108·2	53·6
3	72·0	58·0	2		132·0	68·2	37·3	105·5	51·6
4	75·0	58·0	2		135·0	71·0	37·3	108·3	51·3
1925	80·0	58·0	2		140·0	75·5	36·9	112·4	52·8
6	83·0	56·0	2		141·0	78·5	35·4	113·9	52·9
7	89·0	55·0	2		146·0	84·6	35·9	120·5	56·9
8	95·4	54·7	·8	1·0	151·9	91·7	36·1	127·8	58·7
9	101·2	53·2	·8	1·0	156·2	91·7	36·1	127·8	60·8
1930	106·9	51·4	·9	·9	160·1	103·0	33·6	136·6	62·4
1	108·6	49·7	·9	·9	160·1	105·0	32·6	137·6	63·8
2	109·2	47·1	·8	·9	158·0	105·0	31·9	136·9	66·7
3	114·5	45·5	·8	·9	161·7	109·4	30·8	140·2	66·2
4	118·8	45·8	·8	1·0	166·4	112·8	30·9	143·7	70·4
1935	126·7	45·0	·9	1·0	173·6	119·9	30·5	150·4	72·7
6	136·7	44·1	·9	1·0	182·7	128·3	29·9	158·2	77·3
7	146·9	43·1	·9	1·1	192·0	136·8	29·4	166·2	80·3
8	155·7	42·8	·9	1·1	200·5	143·7	30·3	174·0	83·6
9	162·7	41·5	·8	1·0	206·0	167·6	33·4	201·0	107·4
1940	161·1	40·2	·7	1·0	203·0	214·9	44·1	259·0	158·8
1	179·2	42·8	·8	1·2	224·0	263·5	52·5	316·0	207·5
2	188·0	43·9	·9	1·2	234·0	342·8	69·2	412·0	305·6
3	188·9	38·8	·9	1·1	229·7	412·2	75·8	488·0	369·8
4	189·2	37·3	·8	1·1	228·4	426·7	76·3	503·0	383·6
1945	206·9	38·3	·8	1·1	247·1	473·4	78·8	552·2	403·8
6	220·5	41·5	·6	1·0	263·6	511·8	84·7	596·5	434·0
7	193·1	37·5	·7	·8	232·1	583·3	102·6	685·9	540·3
8	183·9	41·0	·7	·8	226·4	642·3	127·5	769·8	..
9	177·9	40·9	·6	·7	220·1	632·1	128·8	760·9	..

Sources.—J. R. N. Stone, "The Analysis of Market Demand", *J.R. Statist. Soc.*, 1945, p. 339, and the annual White Paper on National Income, with minor changes. Quarterly figures of expenditure on tobacco goods are given in the *Monthly Digest of Statistics* published by the Central Statistical Office. The revenue collected from tobacco duties, on a calendar year basis, is given in Vol. II (Supplement) of the *Annual Statement of the Trade of the U.K.* Fuller details, but on a fiscal year basis (i.e. 12 months ended March 31st), are given in the *Annual Report of the Commissioners of Customs and Excise.*

of Trade sample, but their sales of tobacco are relatively small. The regional figures of the Board of Trade index are based largely on figures received from co-operative societies. Moreover, the figures returned for retail tobacco sales include, in addition to tobacco goods, the sales of matches, pipes, smokers' requisites and any other fancy goods. The Board has always endeavoured to indicate that these particular figures have their limitations, and however much statisticians may appreciate and may wish to encourage the effort made by the Board of Trade to fill a serious gap in distributive trade statistics, there is no doubt that their voluntary sample as at present constituted does not accurately represent the tobacco trade.

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The very high figures for retail sales value quoted above for recent years are, as is well known, almost wholly due to the level of duty. The analysis of the retail prices of a packet of 20 cigarettes at the present time and pre-war is as follows:

TABLE 13

Analysis of the Retail Price of a Packet of 20 Cigarettes

	Present "2s. 7d. for 20" class of cigarettes				*Present "3s. 6d. for 20" class of cigarettes*			
	1938		*Current*		1938		*Current*	
	Pence	%	Pence	%	Pence	%	Pence	%
Duty	4·1	51·2	24·5	79·0	5·6	46·7	33·5	79·8
Manufacturing costs (including profits and taxation)	2·4	30·0	3·6	11·6	3·9	32·5	4·7	11·2
Distributors' margins	1·5	18·8	2·9	9·4	2·5	20·8	3·8	9·0
Retail price	8·0	100·0	31·0	100·0	12·0	100·0	42·0	100·0

Sources.—Current duty figures as given by the Chancellor of the Exchequer in a written answer in the House of Commons, April 5th, 1950 (*Hansard*, 160). Figures of distributors' margins based on published price lists.

Principal Pitfalls

(i) The special discounts or bonuses given to the distributive trade by most tobacco manufacturers are included in "manufacturing costs" and not in "distributors' margins". For the amounts involved pre-war, see J. B. Jefferys, *The Distribution of Consumer Goods*, p. 254.

(ii) While the percentages which distributors' margins bear to retail price are given above, it should be noted that, in the tobacco trade, these margins have been on a cash basis (e.g. 12*s.* or 16*s.* per 1,000 cigarettes), and not on a percentage basis as in most other trades, since April, 1947.

The tobacco duty collected from the home trade is the largest single source of revenue, other than income tax, accruing to the Chancellor of the Exchequer. During the fiscal year 1949–50, tobacco duty collected by manufacturers from the public on behalf of the Exchequer amounted to £600 mn., a sum which is equivalent to the proceeds from an income tax of 3*s.* 9*d.* in the £. At the present time the standard rate of duty on tobacco is 58*s.* 2*d.* per lb., and the value of duty-paid tobacco was actually higher than that of silver before the price of the latter was increased in September, 1949, as a result of devaluation.

The largest single item in the cost of tobacco, after duty, is the cost of the leaf. The following table shows the average landed price per lb. of imports of certain types of flue-cured tobacco during the calendar years 1939 and 1947. The pitfalls to this table should be particularly noted:

TABLE 14

Landed Cost per lb. of Certain Types of Flue-cured Tobacco

		1939	1947	*% Increase*
		(Pence per lb.)		
U.S.A.	Leaf	14·6	35·8	145
	Strips	21·6	46·1	113
S. Rhodesia	Leaf	13·9	48·2	247
	Strips	17·0	49·9	194
India	Strips	12·2	39·4	223
Nyasaland	Leaf	12·7	35·5	180
	Strips	13·0	39·8	206
Canada	Leaf	17·5	33·6	92

Source.—Annual Statement of the Trade of the U.K., 1939 and 1947.

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Principal Pitfalls

(i) While the above table is based entirely upon published figures, any comparisons between different figures given in the table require extremely careful interpretation. It is important to appreciate that each of the 16 cost figures given above covers a different pattern of grades of tobacco.

(ii) The average cost per lb. of leaf imported from different countries cannot be compared because the proportions of the different grades bought in the various countries are not the same. The only fair comparison of, say, U.S. and S. Rhodesian leaf prices is to compare prices for the same grades, and such figures have not been published.

(iii) The differences between the cost of imported leaf and the cost of imported strips do not represent the cost of stripping leaf in the countries of origin, as the proportions of grades stripped abroad are not the same as the proportions of grades imported in leaf form. If, for example, all the lower grades were stripped abroad, it would be possible for the cost of strips to appear to be less than that of leaf.

(iv) The "percentage increase" figure represents the increase in the cost of flue-cured tobacco which happened to be imported in 1947 as compared with 1939, but owing to differences in the proportions of the various grades imported between the two years, it cannot be said that a given grade of tobacco bought in one of the countries has increased by the figure shown.

(v) The figures are for calendar years, being the only form in which the above figures have been published, and consequently they are subject to the disadvantages of calendar year figures, as compared with import year figures, mentioned earlier.

1948 *Census of Production*

It may be worth while to refer to the 1948 *Census of Production*.* As statisticians are aware, this Census was far more comprehensive than any previous Census, and it may be as well to record a few warnings of what the Census figures will *not* mean, in anticipation that the published results will follow the lines of the Census forms. No doubt some of these warnings will be repeated in the eventual Census Report, but this is a subject in which some duplication can do no harm.

For example, the sales figures are not sales to the public but only sales to the distributive trade. The figures of stocks cannot be taken as average stocks over a year since they are the stocks as at the end of the manufacturers' financial year, and the financial year of the largest tobacco manufacturers ends in the autumn, i.e. shortly after the summer holidays, when manufactured stocks would be not far off their lowest level. Again, the various expense items (which were reported under the Section of the Census form in which payments for services rendered by other firms were listed) do not represent the total expenditure under any of the headings concerned, since they represent only amounts paid to outside firms for services which fall under the various specified headings. Thus, expenditure on advertising includes not only the amounts shown in the Section of the 1948 Census form reporting payments for services rendered by other firms, but also the wages and salaries paid to each firm's advertising staff (which are included in the Section of the Census form in which wages and salaries are reported), the cost of materials used in advertising (which are included in the Section reporting materials and fuel purchased), and other items, such as rents and rates on advertising sites, which are entirely omitted from the Census return.

Productivity comparisons based on the 1948 Census of Production and previous Censuses will be affected by a number of factors.† For example, the 1948 Census returns for the tobacco industry will include a considerable (but unspecified) number of part-time employees, whereas practically none were employed before the war. There are also the variations in the Census

* [Later note: The preliminary report has since been published in the *Board of Trade Journal*, June 10th, 1950, pp. 1207–8.]

† Moreover, surely a more adequate index of the "productivity" of a firm as a whole would be one which included the "net value added" (i.e. the value of output less the cost of input) in relation to the capital employed in production as well as the "net value added" in relation to the number of employees, rather than an index, as calculated in the past, on the basis of the latter relationship alone. As Dr. Rostas has stated (*op. cit.*, p. 52), "ultimately we are interested in the amount of real resources used per unit of output".

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coverage referred to above, while some doubts are inevitably raised by the failure of the Census employment figures and Ministry of Labour employment figures to agree. In addition, there are differences between Censuses in the basis on which employers estimated the numbers of employees whom they should exclude as not being employed in connection with the output reported in their return, either because these employees were being reported as employed in a different trade, or because they were engaged in merchanting or other activities not covered by the Census.

On the subject of productivity, it should also be added that it is not really possible to form a reliable idea of the changes in productivity in the manufacture of the various tobacco products by comparing unadjusted published figures of *gross* clearances and employment. A comparison of these figures month by month fails to make allowance for variations in the extent to which the tobacco is cleared in the form of strips, for variations in cleared stocks of unmanufactured leaf, for variations in work in progress, for differences between months in the number of working days, for seasonal and other variations in absence, etc. Over a longer period of several years, the comparison is further vitiated by discontinuities in the employment statistics (some of which are

TABLE 15

Per capita *Consumption of Tobacco Products and Retail Prices in Selected Countries*

Country	*Average Consumption per Adult (i.e. aged 15 and over) per annum*			*Sterling equivalent of current retail price per 10 cigarettes of representative brands of cigarettes*
	Year	*Cigarettes* (Number)	*All Tobacco Products* (lbs.)	
Australia	1939	615	4·4	
	1949	909	5·7	8·4*d.*
Belgium	1939	1,035	8·5	
	1949	1,228	6·4	6·0*d.*
Canada	1938	856	5·2	
	1949	1,772	7·3	14·0*d.*
Denmark	1939	612	7·6	
	1948	894	6·0	15·5*d.*
France	1939	589	3·7	
	1948	858	4·6	10·1*d.*
Irish Republic	1939	1,413	4·8	
	1949	2,308	6·5	10·0*d.*
Italy	1939	671	2·4	
	1949	861	2·5	11·1*d.*
Netherlands	1939	828	9·2	
	1949	857	7·8	8·0*d.*
New Zealand	1939	709	5·8	
	1948	1,294	9·0	8·0*d.*
Norway	1939	361	3·5	
	1948	980	5·3	13·1*d.*
South Africa	1939	663	3·5	
	1949	1,038	4·1	5·5*d.*
Spain	1939	490	3·5	
	1947	484	3·2	4·1*d.*
Sweden	1939	402	3·6	
	1948	710	4·1	19·0*d.*
Switzerland	1939	735	5·5	
	1949	1,251	6·3	7·8*d.*
U.S.A.	1939	1,750	8·5	
	1949	3,188	10·1	7·9*d.*
U.K.	1939	1,955	5·5	
	1949	2,029	5·5	21·0*d.*

[Later note: Some additional figures on a slightly different basis will be found in the *Economic Survey of Europe in 1949*, p. 34. The Irish Government removed all restrictions on clearances of tobacco from July 14th, 1950.]

May 28th, 1950.

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relatively important in the tobacco industry), and to an important extent by variations in the proportions of different goods produced. It would, of course, be particularly erroneous to compare the trends in *net* clearances and employment statistics, since the former exclude exports by excise factories, whereas the latter include export work.

The Distributive Trade and the Consumer

Any notes on tobacco statistics should, if they are to be complete, cover the distributive trade and the consumer as well as leaf supplies and their manufacture. The distributive trade and the consumer, however, each really merit a separate article, and in this note it is proposed to make only passing reference to them. These omissions are not so serious as they might otherwise seem, since the National Institute of Economic and Social Research has just published the results of an inquiry into the methods, costs and structure of distribution in which there is a section on the tobacco trade,* and since the Hulton Press have published two reports containing summaries of the smoking habits of tobacco consumers in the spring of 1948 and 1949 respectively.†

There are about 22,500,000 smokers in Great Britain and Northern Ireland at the present time, and to supply them with tobacco goods, when their average purchase is approximately 20 cigarettes or 1 oz. of tobacco, involves about 5,000,000,000 retail sales transactions per annum. This astronomical task is carried out by a distributive organization consisting of just over 1,000 wholesalers (excluding wholesalers who also own retail outlets) and about 420,000 licensed retail outlets. (The present number of licensed retailers is considerably less than pre-war.) Of these retail tobacco outlets, however, only about 10,000 are "tobacconists only" in the sense that they sell only tobacco goods (apart from smokers' requisites and some miscellaneous fancy goods). For the most part, therefore, tobacco is sold with other goods and services, and it has been estimated that the time employed in retail tobacco distribution, averaged over all outlets, amounts to about one-third of one person's time per retail outlet for tobacco.

Per capita *Consumption and Retail Prices in Different Countries*

It is interesting to compare pre-war and post-war *per capita* consumption of tobacco products and the current official retail price per 10 cigarettes of representative brands of cigarettes in different countries. These figures are set out for the more important countries in Table 15.

Appendix I

"*Cavendish and Negrohead*"

Originally the terms "Cavendish" and "Negrohead" were used by the trade to designate specific types of manufactured tobacco. Cavendish was (and is) made from leaf which has been subjected to some degree of heat and pressure and, after being coarsely cut, is generally sold in this form or used as an ingredient of smoking tobacco mixtures. (Authorities disagree as to the origin of the name. According to F. W. Fairholt, *Tobacco, Its History and Associations*, 1876, p. 124, it was called after the great sea captain; according to the *Oxford English Dictionary* the earliest record of the term is 1839 and it may represent a manufacturer's name.) Negrohead is made from leaf which has first been spun and then twisted, is generally pressed and may have been subjected to heat as well as pressure. The terms are still used in these senses by the trade.

Under the Manufactured Tobacco Act of 1863 (26 Vict. c.7) it was made legal to manufacture cavendish and negrohead in bond, and the specific advantage of manufacture in bond was that the addition of sweetening material to the tobacco was then permitted. In consequence, the terms "cavendish" and "negrohead" as applied in the Customs and Excise statistics, and more particularly the former term by itself, came to mean "all sweetened tobacco," and this extension of the terms covered not only smoking tobacco, but also cigars, cigarettes or any other form of manufactured tobacco to which sweetening material had been applied. As a result of this exten-

* J. B. Jefferys, *The Distribution of Consumer Goods*, pp. 252–5. *The Report of the Committee on Resale Price Maintenance* (Cmd. 7696), pp. 52–9, also contains an outline of some of the main features of the tobacco distributive trade.

† *The Pattern of Smoking Habits*, published in 1948, and *Patterns of British Life*, pp. 53–5 and 122–5, published in 1950.

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sion of the term, imports of sweetened smoking tobacco also became classified as "cavendish," while exports of sweetened smoking tobacco (but not of sweetened cigarettes) were similarly classified as "cavendish." (Exports of sweetened cigarettes were classified as "cigarettes".) The Customs and Excise statistics thus contained in effect two different definitions of cavendish—one meaning "all sweetened tobacco manufactured in bond", when considering the manufacturing aspect, and another as meaning "sweetened smoking tobacco" in the import and export statistics. The situation has become slightly less confused at the present time, since the only tobacco at present manufactured in bond is sweetened tobacco, and consequently the terms "British manufactured cavendish and negrohead" are now synonymous with "British tobacco manufactured in bond". The terms "cavendish" and "negrohead", however, continue to be used in the import and export statistics as meaning "sweetened smoking tobacco", and naturally they are still used by the trade in their original and traditional sense.

The confusion over the use of the terms "cavendish" and "negrohead" was increased for a time by the Board of Trade in its pre-war Censuses of Production, when manufacturers were required to classify their output of manufactured tobacco into cigars, cigarettes, cavendish or negrohead, other manufactured tobacco, and snuff for human use. In completing their returns, manufacturers (presumably) took "cavendish or negrohead" to mean all sweetened tobacco, whether smoking tobacco, cigarettes or cigars. This source of confusion was eliminated from the 1948 Census of Production by the introduction of a specific distinction between goods manufactured in excise factories and goods manufactured in bonded factories.

Appendix II

Selected Bibliography

I. *General*

W. W. Garner, *The Production of Tobacco*, published by Blakiston Co., Philadelphia, 1947.
A. E. Tanner, *Tobacco*, published by Pitman. Out of print (at present reprinting).
Annual Report on Tobacco Statistics, Production and Marketing Administration, U.S. Dept. of Agriculture. (Latest edition is for 1949.)
Tobacco Year Book, 1940, published by Industrial Newspapers Ltd. (This was the last full issue of what was, before the war, a valuable annual book of reference on the tobacco trade.)
The Smokers' Handbook, published by Industrial Newspapers Ltd. This publication lists manufacturers' brands and retail prices.

The following publications contain useful sections on tobacco from the point of view of the particular subject with which they deal:

J. R. N. Stone, "The analysis of market demand", *J.R. Statist. Soc.*, 1945, **108**, p. 339.
G. F. Shirras and L. Rostas, "The burden of British taxation", *N.I.E.S.R.*, 1942, pp. 124–36.
L. Rostas, "Comparative productivity in British and American industry", *N.I.E.S.R.*, 1949, esp. pp. 200–8.
N. Kaldor and L. Silverman, "A statistical analysis of advertising expenditure and the revenue of the Press", *N.I.E.S.R.*, 1948.
J. B. Jefferys, "The distribution of consumer goods", *N.I.E.S.R.*, 1950, esp. pp. 252–5.
Patterns of British Life, pp. 53–5 and 122–5, Hulton Press, 1950.
Report of the Committee on Resale Price Maintenance (Cmd. 7696), pp. 52–9.

II. *Tobacco Cultivation*

Plantation Crops, Commonwealth Economic Committee, 1950 and 1948. This report was also published pre-war. The 9th and 31st Reports of the Imperial Economic Committee (both entitled *Tobacco*), published in1928 and 1937 respectively, are both of interest for descriptions of the trade at the time they were written.
Tobacco Situation, issued quarterly by the Bureau of Agricultural Economics, U.S. Dept. of Agriculture.
Foreign Crops and Markets, issued weekly by the Office of Foreign Agricultural Relations, U.S. Department of Agriculture.
Foreign Agriculture, issued monthly by the Office of Foreign Agricultural Relations, U.S. Department of Agriculture.
Foreign Agriculture Circulars—Foreign Market Notes—Tobacco, issued at irregular intervals by the Office of Foreign Agricultural Relations, U.S. Department of Agriculture.

Those interested in tobacco growing in the Commonwealth, especially Africa, may be referred to the *Report on Tobacco*, by S. S. Murray (Colonial Research Publications No. 4, H.M.S.O., 1949) and the *Second Report of the Colonial Primary Products Committee* (Col. No. 238, published by H.M.S.O., 1949, pp. 50–6). The bi-monthly *Empire Producer* (Journal of the British Empire Producers' Organization) frequently contains items about tobacco growing in the Commonwealth.

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III. *U.K. Official Statistics*

The following is a brief guide to the main published Official Statistics on tobacco:

Tobacco Intelligence and *Tobacco Bulletin* issued by the Commonwealth Economic Committee.

These periodicals give the latest particulars of U.K. imports, clearances and stocks of unmanufactured tobacco and exports of manufactured tobacco, and of production, prices, stocks (where available) and exports of unmanufactured tobacco of the various tobacco-growing countries. Certain further details of international trade in unmanufactured and manufactured tobacco are included when available.

Annual Report of Commissioners of Customs and Excise.

This report gives, *inter alia*, the following statistics for the year ended March 31st:

Quantities of unmanufactured and manufactured tobacco entered for consumption or deposited for drawback, under various classifications.
Receipts from duty and drawback paid.
Cost of duty relief to old age pensioners.
Quantities of tobacco exported, under various headings.
Quantities of tobacco delivered for ships' stores and for H.M. Forces overseas.

Monthly Trade and Navigation Accounts

This report gives the following statistics in respect of the month covered:

Quantity and value of imports and exports of unmanufactured and manufactured tobacco.
Unmanufactured and manufactured tobacco cleared from bond or deposited for drawback.
Bonded stocks of imported tobacco.

Annual Statement of the Trade of the U.K.

This report gives the following figures on a calendar year basis:

Imports and exports of unmanufactured tobacco, under various classifications.
Unmanufactured and manufactured tobacco entered for home consumption or deposited for drawback, distinguishing amounts subject to full duty and preferential rate respectively.
Revenue collected from foregoing classes of tobacco.
Cost of duty relief to old age pensioners.
Imported manufactured and unmanufactured tobacco in bonded warehouses at December 31st.
Manufactured and unmanufactured tobacco delivered duty-free from bonded warehouses for ships' stores, etc.

Annual Report on National Income

Personal expenditure on tobacco goods before and after deduction of taxes, at current and 1948 prices.

Annual Financial Statement

Revenue collected from tobacco and current and proposed rates of duty (when a change is proposed).

Monthly Digest of Statistics

Clearances and stocks of tobacco.
Personal expenditure on tobacco.
Deliveries for home and export of tobacco and cigarette making machinery.

Ministry of Labour Gazette

Various employment statistics are published from time to time.

Tables relating to Employment and Unemployment in Great Britain, 1948 (*and earlier years*)

This report gives a regional analysis of the numbers employed in various industries, including the tobacco industry.

Census of Production Reports

These contain the usual Census details.

IV. *U.K. Tobacco Trade Journals*

(Mainly representing the distributors' point of view.)

Tobacco, published by Industrial Newspapers, Ltd.
The Cigar & Tobacco World, published by Heywood & Co., Ltd.
N.U.R.T. Journal, the official organ of the National Union of Retail Tobacconists.
The Tobacconist & Confectioner, published by William Reed, Ltd.

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V. *Historical*

A considerable literature is available on the history of smoking, and particular mention should be made of the monumental *Tobacco*, of which four volumes have already been published, by G. Arents (Rosenbach Co., New York). Very little has been published, however, on the economic and statistical history of the tobacco trade, although useful contributions to certain aspects are contained in C. M. MacInnes (*The Early English Tobacco Trade*, Kegan Paul, 1926) and A. Rive ("The Consumption of Tobacco since *1600*", *Econ. Hist.* (*Ec. J. Supp.*), Jan., 1926, pp. 57–75). In view of this gap, it may be of interest to compare with current figures the following analysis of the average retail price per lb. of tobacco which prevailed in 1870: duty cost, 29·0*d.*; leaf cost, 6·9*d.*; other manufacturing costs, 13·3*d.*; distributors' margins, 8·8*d.*; retail price, 58·0*d.*

VI. *Miscellaneous*

For those interested in comparisons with other countries, the most useful introductions are the *Annual Report on Tobacco Statistics*, mentioned above, for U.S.A., the *Tobacco Industries, 1948, in Canada* and the *Historical Series of Tobacco Statistics* (D.B.S. Reference Papers, 1950, No. 1) published by the Dominion Bureau of Statistics, Ottawa, and the *Report on the Tobacco Manufacturing Industry* (Report No. 317) in South Africa, by the Board of Trade and Industries, Union of South Africa. For a survey of countries where the industry is a government monopoly, *The State as Manufacturer and Trader*, by A. W. Madsen, published by Unwin in 1916, has never been superseded.

As a lighter note, perhaps it should be added that, for the connoisseur of cigarette cards (which the trade still call "stiffeners"), a useful work is *Cigarette Card Cavalcade*, by A. J. Cruse, published by Vawser & Wiles, London, 1948. There are also two periodicals devoted to this subject—the *Cigarette Card News*, published by the London Cigarette Card Co., Ltd., and the *Cartophilic World*, published by the Cartophilic Society.

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The Sources and Nature of Statistical Information in Special Fields of Statistics

Electricity and Gas Statistics

By G. H. Daniel

Although electricity and gas serve similar needs and have been in competition with each other during the greater part of their development, the nature of the two products, the organization of the two industries and the division of Departmental responsibilities for them have been sufficiently distinct to result in large differences in their statistics. In the present paper it will be convenient, therefore, to survey each industry in turn.

Because the statistical sources for an industry largely reflect the history of its organization and the publicly recognized problems of the day, it will also be advantageous to review briefly the history of these sources before describing their content.

Electricity

It is an excusable exaggeration to say that for the electricity supply industry the dividing line between statistical history and pre-history is 1920—the first year covered by the Electricity Commissioners' annual returns. The industry itself cannot be said to have started until the beginning of the eighties of the last century, when the first private companies were floated and local authorities began to take powers to supply electricity to the public. During the last two decades of the century only small generating plants could be built; the large losses incurred in transmitting low voltage direct current strictly limited the areas that could be served; and, because electricity was used almost entirely for lighting, the generating plant was idle for a great part of the day. Prices were high in relation to those of alternative fuels, and the financial basis of many of the undertakings was shaky. During this first experimental period there was little technical case for integrating or co-ordinating the growing numbers of small undertakings, and public interest centred mainly in technical progress and the relative merits of company and municipal ownership. The basic legislation of the time—the Electric Lighting Act of 1882—provided for the establishment of local authorities or companies as "electricity undertakers", with rights such as those of breaking up streets, and obligations such as those for developing their area of supply within a given time and not exceeding certain maximum prices. It is true that Section 9 of the Act required authorized undertakers to prepare and publish annual statements of accounts in prescribed forms, but the main object of this provision was to ensure that adequate accounts were available of the affairs of individual undertakers. The Board of Trade, which administered the Electric Lighting Acts, was not empowered or constituted to co-ordinate the development of the industry, and it is easy to appreciate why, for these early years, no official national statistics were issued.

The technical institutions and press, however, were active from an early date, and publications such as the *Journal of the Institution of Electrical Engineers*, the *Electrical Review*, *Electrical Times* and the *Electrician* contained a good deal of useful quantitative information, largely drawn from the published accounts of the undertakers. Towards the end of the century Garcke produced his well-known *Manual of Electrical Undertakings*, the first edition of which covered the year 1896. Based on the published accounts, this gave for each authorized undertaking particulars of its financial position, and also of the amounts of electricity generated and sold, the numbers of lamps and customers served, the prices authorized and charged, the horse-power of the engines installed and the nature of the distribution system. In their preface to the first edition the publishers announced that they had been reluctantly compelled by "the exigencies of space to exclude some valuable statistical and technical information submitted by the editor". The editor subsequently changed his publishers, and later issues of the *Manual* included national summaries, extending over a series of years, of the more important of the figures given for the separate undertakers.

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During the next two decades—that is, the first 20 years or so of the present century—there was growing conflict between the organization of the industry on the basis of a large number of small private companies and local authorities and the technical requirements for co-ordination of effort on a regional and national scale. The steam turbine, the practical application of three-phase alternating current, and the development of the electric motor pointed inexorably to the large power station, high voltage transmission over long distances, and multiplication of the scale of industrial use. After the report of the Cross Committee, power companies were set up under Private Acts for the purpose of generating and distributing electricity in bulk, but the rights of existing undertakings were protected, and the inevitable outcome of uncoordinated development was the continuation of hundreds of small, high-cost generating stations, small areas of distribution, and a multitude of different systems of supply, pressures and frequencies. In the absence of a central authority, the statistical information for the industry remained confined to the technical press and the efforts of individual students. The First World War demonstrated the needs for rapid expansion of industrial electrification, and appeared to bring the issue of reorganization to a head. Following the report of the Williamson Committee, the Electricity (Supply) Act of 1919 provided for the appointment of Electricity Commissioners responsible to the Minister of Transport for promoting, regulating and supervising the supply of electricity.

The original proposals to give the Commissioners far-reaching executive powers to reorganize the industry by constituting and controlling District Electricity Boards, which were in turn to take charge of wholesale supplies and effect a regional reorganization of their areas, were defeated in Parliament, and the powers finally given to set up Joint Electricity Authorities with the voluntary agreement of the undertakers concerned proved inadequate. But although they lacked effective powers, the Commissioners were fully alive to the technical needs for reorganization. As they said in their first Annual Report, they also appreciated the importance of comprehensive official statistics: "Not only on account of the position occupied by the electricity supply industry in this country, but also to enable them adequately to follow the progress of different undertakings and districts, to see whether the resources of undertakings and districts were being utilized to the fullest advantage, and to frame proper measures for the pooling and concentration of such resources in the interests of the community." Section 27 of the 1919 Act had made it the duty of the undertakers to furnish the Commissioners with such accounts, statistics and returns as they might require. These powers, the Commissioners' appreciation of the importance of reliable information and the widespread recognition of the need for reorganizing the industry go a long way to explain the comprehensive nature of the annual statistics which the Commissioners proceeded to build up—statistics which are among the most complete ever published for a British industry.

Four-weekly returns of units generated, fuel consumption, etc., had been instituted by the Coal Controller during the First World War, and later continued by the Electric Power Supply Department of the Board of Trade. With some amendments these returns were continued by the Commissioners, and formed the basis of their annual report on *Generation of Electricity in Great Britain*. First issued in respect of 1920, this report gives on a calendar year basis for each separate station the more important engineering particulars, such as the type of station, units generated and sent out, fuel consumption per unit, thermal efficiency, maximum load and load factor.

The main statistical effort of the Commissioners was based, however, on their annual 12-page statistical form of return, El.C.32. Section A of this return asked for administrative details, such as the extent of the area of supply, numbers of premises and consumers, the staffs employed and their salaries and wages. Section B dealt systematically with the undertaker's finances, the capital or loans raised and expended, operations on revenue account, the appropriation of the surpluses on this account, and the changes in depreciation, reserve and other balances. It also requested particulars of the tariff of electricity charges in force at the end of each year. Finally, Section C called for a detailed engineering description of the undertaking and its operations. This covered in turn the system of supply, generators, boilers, condensing facilities, transmission lines, the amount of electricity generated, purchased, used and sold, an analysis of sales according to consumers, and details of maximum load, load factor and fuel consumption. Although the new form of return was thoroughly discussed with technical and other bodies, it called (particularly on the financial side) for more information than many undertakings could readily provide. The

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Commissioners had regretfully to report that there was lack of appreciation in a number of cases of the importance of accurate and up-to-date statistics, and the financial particulars on the first return had later to be regarded as experimental. It was not until May, 1925, that the Commissioners were able to publish their first *Return of Engineering and Financial Statistics* covering the three financial years ending with 1922/23. This publication, which, until the Second World War, was issued annually, and which came to an end with the issue for 1947/8, gives not only national summaries of all the more important information collected on Form El.C.32, but also separate particulars for each undertaker.

Apart from the reduction in the amount of detail collected and published after the outbreak of the Second World War, the only substantial changes made in the Commissioners' annual statistics were those introduced in the *Return of Engineering and Financial Statistics* for 1932/3 as a result mainly of the Electricity (Supply) Act of 1926. Following the suggestion made by the Lloyd George Committee on Fuel and Power and the recommendations of the Weir Committee, this Act resolved the contradiction between maintenance of private enterprise and technical requirements for centralized control by setting up the Central Electricity Board. The Board did not acquire the generating stations, nor was it authorized to sell electricity direct to consumers (although in 1935 an exception was made for the supplies needed by the railway companies for traction purposes, and the Board later brought into commission and operated the Earley power station). The Board was empowered to construct main transmission lines (known as the Grid) and to standardize frequency, and with the necessary physical means created in this way, it discharged its responsibility of ensuring that national requirements were generated in the most economical way by purchasing the total output of the country's main stations (the selected stations, the operations of which it directed as necessary), and by selling supplies in bulk to authorized undertakers, including the owners of the selected stations. General trading operations on these lines began on January 1st, 1933, and some transactions had taken place earlier. The new arrangements made it necessary to change the presentation of the statistics for the industry. The Commissioners also took the opportunity in their 1932/33 volume to make certain other changes—particularly in the financial statistics—that experience had suggested to be desirable.

During the Second World War there was an extension of the short-period statistics for electricity supply as there was for other industries, the extension in this case being partly associated with the development of solid fuel programming. Previously the only published short-period statistics were the monthly figures of electricity generated and electricity sent out, which the Electricity Commissioners began to release to the technical press in 1930. Since January, 1946, monthly statistics, which now cover fuel consumption, electricity generated, electricity sent out, generating capacity installed and maximum simultaneous demand, have been published in the Central Statistical Office's *Monthly Digest of Statistics*. The Ministry also publishes in its *Weekly Statistical Statement* the number of units sent out by all the solid fuel-fired stations of the British Electricity Authority and North of Scotland Hydro-Electric Board.

But the main changes in statistical sources since the end of the war are, of course, those arising from the nationalization of the industry. The McGowan Committee had reported in 1936 and the Government of the day had accepted, that the distribution side of the industry needed reorganization on the basis of larger units, and after the return of the Labour Government in 1945, the Electricity Act of 1947 provided for complete reorganization by establishing the British Electricity Authority (the Central Authority) and fourteen Area Electricity Boards to own and operate the industry, except in the North of Scotland District, where the North of Scotland Hydro-Electric Board with separate responsibility for both generation and distribution had been established by an Act of 1943. The Area Electricity Boards are responsible for distribution in their areas, while the Central Authority has the task of generating electricity and supplying it to the Area Boards and, in addition, has certain general responsibilities for policy and finance. It, the Area Boards and the North of Scotland Hydro-Electric Board are collectively referred to as the Electricity Boards. The British Electricity Authority and Area Boards took up their responsibilities on April 1st, 1948. Under Section 46 of the 1947 Act they are under an obligation to keep proper accounts and other records in relation to their businesses, and to prepare for each financial year statements of accounts in accordance with a form directed by the Minister of Fuel and Power with the approval of the Treasury. The Authority published its *First Report and Accounts* in December, 1949; at the same time a separate report was published by each Area

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Board. These reports give full particulars of the financial position and operations of the authorities. Besides giving a great deal of valuable information of a general character about the administration of the industry, its generating and transmission systems, and its tariffs and commercial operations, the Reports give statistics for the main subjects covered by the Electricity Commissioners. Useful information is also given in the *Annual Reports* of the North of Scotland Hydro-Electric Board.

In accordance with the provisions of the 1947 Act, the Commissioners were dissolved as from August 1st, 1948. At that date their annual *Return of Engineering and Financial Statistics* had not been issued for 1946/47 and 1947/48, and the Ministry of Fuel and Power accordingly arranged to complete the series by issuing the volumes for these years.

To provide, after the dissolution of the Electricity Commissioners, for the continued supply of the detailed information it needs about the industry, including the part not covered by the British Electricity Authority and the Area Boards, the Ministry drew up new forms of return for the year 1948 and subsequent years. These forms were designed so as to ensure, as far as possible, continuity with the Commissioners' statistics, and at the same time, comparability with the statistics for the other fuel and power industries and with the schedules of the Census of Production Office. They ask for enough details about persons employed, wages and salaries, materials purchased, capital expenditure, and the value of output and other work done to meet the requirements of the Census Office, and make it unnecessary for overlapping returns to be rendered both to it and to the Ministry. The information is called for on a calendar year basis, and is published in the Ministry's *Statistical Digest* for 1948 and 1949 alongside similar information for the other fuel and power industries.

Definition of the Electricity Supply Industry

Before nationalization, the entire field of electricity generation and distribution was divisible as follows:

(*a*) Authorized undertakers. These were the undertakers authorized by Parliament to engage in the business of supplying electricity to the public, either directly, or indirectly through other authorized undertakers. At the end of the financial year 1947/48 they comprised the Central Electricity Board, 369 public authorities and 190 companies. The public authorities consisted of the North of Scotland Hydro-Electric Board, 359 local authorities, 6 Joint Boards (representative of local authorities), and 3 Joint Electricity Authorities set up under the 1919 Act, with co-ordinating powers of regulation and control over authorities in their area and with a control over generating stations which, in later years, they exercised under the direction of the Central Electricity Board. The 190 company undertakers included a few composite companies supplying gas, or gas and water, as well as electricity, and 27 electric power companies. Three of the local authority and one of the company undertakers did not exercise their powers of supply. The total amount of electricity generated by all authorized undertakers in 1947/48 was 42,698 million units.

(*b*) Railway and transport undertakings generating power for railways and tramways. In 1947 these generated 1,404 million units.

(*c*) Non-statutory undertakings selling electricity to the public without statutory powers. Some were mainly engaged in this business, but these were operating on a very small scale. Others (which also fall under heading (*d*) below) were larger units which supplied small quantities to nearby premises, incidentally to generating electricity for their own use. The aggregate of all these non-statutory supplies was an almost negligible fraction of the sales of authorized undertakers, and the undertakings have been generally ignored for statistical purposes.

(*d*) Industrial undertakings generating electricity mainly for their own use. These undertakings are especially important in the coal-mining, paper, chemical, and iron and steel industries. According to the Census of Production, factory and non-factory trades (excluding electricity undertakings) consumed 14,865 million units in 1935, of which they purchased 7,720 million and generated 7,145 million units. The stations under this heading have always been regarded as belonging to their individual parent industries and not to the electricity supply industry.

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On nationalization, the North of Scotland Hydro-Electric Board took over the assets and liabilities of seven local authority and nine company undertakers as well as those of one holding company. The remaining undertakers, except for four local authorities, one company and one Joint Electricity Authority, which had not exercised their statutory powers, vested in the British Electricity Authority and the 14 Area Boards. The distribution assets of the Lochaber Power Company had earlier been acquired by the North of Scotland Board, and the large hydro-electric plant of this undertaking was not taken over. The non-statutory undertakings did not vest, but those of them entitled to do so under section 48(1) of the 1947 Act could apply to be transferred to the appropriate Area Board, and a number of such transfers have taken place.

The annual and monthly electricity statistics of the Ministry of Fuel and Power and the Electricity Commissioners, including the electricity statistics published by the Central Statistical Office, relate essentially to the authorized undertakings referred to under (*a*) above and, since nationalization, to the undertakings which now cover broadly the same field—that is, the British Electricity Authority, the Area Electricity Boards—the North of Scotland Hydro-Electric Board and the Lochaber Power Company. The annual electricity statistics of the Ministry and the Commissioners also show separate particulars for railway and transport undertakings.

The Ministry's coal statistics (which give details of the coal position in the electricity industry) include both the authorized undertakings (and their successors since nationalization) and the railway and transport undertakings. The coal consumed by these stations is at present about 3 per cent. more than the amount consumed by the authorized undertakings only.

The Ministry's figures of units sent out from solid fuel-fired stations issued to the press in its *Weekly Statistical Statement* relate only to the solid fuel-fired stations of the authorized undertakings and their successors since nationalization. The units sent out from these stations are about 3 per cent. less than the total number of units sent out from all stations of these authorities.

All the electricity statistics referred to cover Great Britain only. Before nationalization, the geographical coverage of the individual authorized undertakings is conveniently shown by the map compiled by the Ministry of Town and Country Planning and published by the Ordnance Survey in 1946. The coverage of the Electricity Boards and of the corresponding Divisions of the Central Authority, which are the units on which geographical analysis must now be based, is shown by the map in the Ministry of Fuel and Power's *Statistical Digest* for 1948 and 1949.

Periods of Time Covered

The Ministry of Fuel and Power's main monthly electricity statistics, as given in the electricity tables to the Central Statistical Office's *Monthly Digest of Statistics* and the supplement to the *Weekly Statistical Statement*, refer to calendar months. The Ministry's coal statistics are based on weekly returns, and the monthly figures of electricity coal consumption and stocks given in the coal tables of the *Monthly Digest of Statistics* refer to statistical months of four or five weeks. These short-term figures are naturally affected by differences from year to year in the incidence of public holidays. Moreover, in studying the changes in weekly or monthly (and also, indeed, in yearly) figures, allowance must always be made for any differences in air temperature, since these have a marked effect on electricity sales and coal consumption.

So far as annual statistics based on short-period returns are concerned, the figures of units sent out by solid fuel-fired stations given in the *Weekly Statistical Statement* relate to periods of 52 weeks. The weekly averages for years in the coal tables of the *Monthly Digest* are 7/365ths or 7/366ths of calendar year totals. Calendar years are also the basis of the annual figures in the *Monthly Digest* electricity table and the Electricity Commissioners' *Return of Generation of Electricity in Great Britain*.

The more detailed annual statistics have been based on a mixture of calendar and financial year returns. The annual engineering and financial statistics of the Commissioners were built up from financial year returns. For the Central Electricity Board, Joint Electricity Authorities and company undertakers the financial year was the calendar year; for local authorities in England and Wales it was the year ending March 31st; and for Scottish local authorities it was that ending May 15th. The financial year of the British Electricity Authority and of the Area Electricity Boards ends on March 31st, and the majority of the statistics given in their Annual Reports are on this basis. The financial year of the North of Scotland Hydro-Electric Board

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is the calendar year. With the object of maintaining comparability for the whole of the fuel and power industries, the Ministry's *Statistical Digest* for 1948 and 1949 relates as far as possible to calendar years throughout.

Plant Capacity

Several different definitions of plant capacity are in use. The widest is that of installed capacity (maximum continuous rating). This is the maximum continuous rating of the generating sets in the stations, including auxiliary and stand-by sets, which are connected to the prime movers and to the busbars and are suitable for use. Scrapped plant and any other plant which has been disconnected and written off are excluded, but no regard is had to any limitations in the capacity of the prime movers nor to the amount of electricity used in the station itself. The installed capacity is expressed in terms of kilowatts installed (written kWI). In dealing with large figures, it is frequently expressed in terms of megawatts installed, one megawatt being equivalent to a million watts or a thousand kilowatts. For many of the older thermal stations, the maximum continuous rating of the generators may give too high a figure of their true capacity. In the case of hydro-electric stations the rating usually assumes normal water conditions, and may on occasion be exceeded in practice. Historically, the installed capacity (M.C.R.) is the most important measure of capacity, since it was used by the Electricity Commissioners and is the only definition on which a long run of figures is available.

The output capacity of a station allows for station consumption and any limitations in the capacity of the prime movers. It is expressed in terms of the kilowatts or megawatts sent out (kWso or MWso).

The most restrictive definition is that of available capacity, which is the output capacity less the losses due to breakdowns, overhauls, bad fuel and other factors which limit the amount of electricity that can actually be sent out from the station at a particular time. These losses, of which those due to breakdowns or overhaul are the most severe, have been declining since 1944, but still amount to 10 per cent. or so of output capacity even when available capacity is at its maximum. Because overhauls are concentrated as much as possible into the summer months in order to secure the maximum available capacity in the winter, the available capacity shows a marked seasonal variation.

Units Generated, Sent Out, Purchased, Sold and Lost

The measure of electrical energy generated or consumed is the Board of Trade unit of one kilowatt hour (kWh), which is equivalent to one thousand watts consumed for one hour. Table 1 throws light on the meaning of units generated, sent out, etc., and the way in which the sales of electricity between authorized undertakers were dealt with by the Commissioners in arriving at national totals.

The units sent out are the units generated less the units used by the stations themselves. The total purchases of undertakers from each other as returned to the Commissioners did not exactly tally with their total sales to each other, mainly because of the difference in the financial years of undertakers. Again, the sales of one undertaker were augmented by its purchases from another, and in arriving at the total availability for sale to the actual consumers of particular groups of undertakers, such as all company undertakers, it was necessary to exclude bulk transactions between the undertakers within the group concerned. Accordingly, inter-purchases within the group were added by the Commissioners, and inter-sales within it subtracted, in arriving at the group's total availability for sale.

The generation of electricity by stations operated under direction of the Central Electricity Board was carefully distinguished by the Commissioners from generation by stations which the undertakers operated independently. The whole of the output of the former stations was sold to the Central Electricity Board, and could not be regarded as forming part of the undertakers' availability for direct sales to consumers. This availability consisted of their purchases of electricity from the Board, plus any supplies generated by them independently, plus purchases from other authorized undertakers, less any sales to the latter undertakers. Just as the units sent out by stations operated under the direction of the Board were excluded from the calculation

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TABLE 1

Units Generated, Sent Out, Purchased, Sold and Lost by Authorized Undertakers—1947/48

Million units

	Companies	*Public Authorities*	*Central Electricity Board*	*Total*
Units generated				
1. Stations under C.E.B. direction	17,089	23,763	..	40,852
2. Independent Stations	1,018	289	539	1,846
3. Total	18,107	24,052	539	42,698
Used on works				
4. Stations under C.E.B. direction	925	1,442	..	2,367
5. Independent stations	36	97	29	162
6. Total	961	1,539	29	2,529
Units sent out				
7. From stations under C.E.B. direction	16,164	22,321	..	38,485
8. From independent stations	982	192	510	1,684
9. Total	17,146	22,513	510	40,169
10. *Purchased from outside sources*	43	46	105	194
Transactions between C.E.B. and other authorized undertakers				
11. Purchases by companies and public authorities	16,028	22,162	..	38,190
12. Purchases by C.E.B.	..	..	38,521	38,521
13. Sales by companies and public authorities of electricity generated under C.E.B. direction	16,164	22,321	..	38,485
14. Sales by companies and public authorities of other electricity	106	..	..	106
15. Sales by C.E.B.	..	..	38,162	38,162
16. Excess (+) or deficiency (−) of total purchases over total sales (items 11 and 12 less items 13–15)	−242	−159	+359	−42
Transactions between companies and public authorities				
17. Purchases	1,129	2,299	..	3,428
18. Sales	2,319	1,092	..	3,411
19. Excess (+) or deficiency (−) of purchases over sales	−1,190	+1,207	..	+17
Inter-Company and inter-public authority transactions				
20. Inter-purchases	4,480	2,568	..	7,048
21. Inter-sales	4,488	2,532	..	7,020
22. Excess (+) or deficiency (−) of inter-purchases over inter-sales	−8	+36	..	+28
Net supplies available for sale to consumers				
23. Units sent out from independent stations plus purchases from outside sources (item 8 plus item 10)	1,025	238	615	1,878
24. Undertakers' purchases from C.E.B. less sales to the Board of electricity other than that generated under C.E.B. direction (item 11 less item 14)	15,922	22,162	..	38,084
25. C.E.B. purchases from, less sales to, other authorized undertakers (item 12 less item 15)	..	..	359	359
26. Excess (+) or deficiency (−) of purchases over sales in all other transactions between authorized undertakers (item 19 plus item 22)	−1,198	+1,243	..	+45
27. Net supplies (total of items 23–26)	15,749	23,643	974	40,366
28. *Sales to consumers*	14,072	21,671	240	35,983
29. *Units lost in transmission, distribution, etc., and unaccounted for* (item 27 less item 28)	1,677	1,972	734	4,383

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of the authorized undertakers' availability for direct sale to consumers, so also the Board's receipts of such electricity and its bulk supplies to undertakers were excluded from the calculation of its availability for direct sales to consumers.

The figures of sales made to consumers (item 28) refer to the actual sales returned in each undertaker's revenue account, and the difference between these sales and the availability for sale reflects, therefore, not only transmission losses, but also consumption in the undertakings' show-rooms, offices, etc., and delays in reading meters.

The British Electricity Authority has now replaced the Central Electricity Board, and supplies electricity in bulk to the Area Boards. These sales, together with other transactions between the Central Authority, Area Boards and North of Scotland, are also netted off in arriving at the present national totals of the electricity available for sale to consumers.

Maximum Load, Maximum Demand and Load Factor

The maximum load on a station is measured as twice the largest number of units sent out by the station's generators during any consecutive 30 minutes commencing or terminating at the hour and is expressed in kilowatts (kW). The station's load factor is the total number of units sent out by it during the year expressed as a percentage of the total number of units that would have been sent out if the station had continued to operate at maximum load throughout the 8,760 hours of the year (8,784 hours in leap years). The maximum load on, and the load factor of, stations is sometimes given also in terms, not of the units sent out, but of the total units generated, including units generated by house service sets.

Similar measures were given by the Commissioners in respect of each authorized undertaking. In this case the maximum load on the undertaking during the year was defined as the maximum total supply which it had available during any consecutive 30 minutes commencing or terminating at the hour as the result of generating electricity for its own purposes and/or of purchasing electricity from the Central Electricity Board and other sources. The generation of electricity at stations operated under the direction of the Board was excluded, and the amount generated independently was measured in terms of the total generated, including generation by house service sets. The undertaking's load factor was the total amount generated independently and/or purchased by it during the year expressed as a percentage of the supplies that it would have had available if it had operated continuously at maximum load throughout the year.

In comparing these measures over a period of years, it should be borne in mind that the Commissioners' earlier forms of return did not specify that the maximum load should be measured over a full half-hour, but asked only that peaks of not more than a few minutes' duration should be excluded. It also needs to be remembered that, because the figures of maximum load for each undertaking include its bulk purchases from other undertakings, their aggregation for the whole country yields figures substantially in excess of the demands of consumers.

Again, because of the non-coincidence in time of all the individual maximum loads on stations, their aggregate value is in excess of the combined (simultaneous) maximum load on the electricity supply system as a whole at any one time; the stations being largely inter-connected by means of the Grid, it is the simultaneous load that is of special significance. Furthermore, the load on the stations, as measured by the maximum amount generated, is not a proper measure of the true demand whenever the latter is in excess of the maximum available capacity. To meet these points, the Central Electricity Board developed figures of simultaneous maximum demand, which measure the maximum demand on the Grid as a whole at any one time, after allowing for any load shed or any reduction in frequency resulting from shortage of capacity. The figures of simultaneous maximum load given in the Central Statistical Office's *Monthly Digest of Statistics* is the simultaneous maximum demand on the Grid plus the maximum demands met by independent stations not connected to the Grid.

Fuel Consumption and Thermal Efficiency

The Ministry's coal and coke statistics, which include consumption and stock figures for the electricity industry, relate to all solid-fuel-fired stations, including railway and transport stations, and in the case of coke they do not include coke breeze. The Ministry's electricity statistics,

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which include details of consumption of coal and coke, cover authorized undertakers only and include consumption of breeze. The great part of the coke consumed by the electricity industry is in the form of breeze.

The Electricity Commissioners published statistics of total fuel consumption per unit both on the basis of units sent out (in the *Return of Generation of Electricity in Great Britain*) and on the basis of units generated (in the *Return of Engineering and Financial Statistics*). In interpreting those figures, a distinction must always be made between steam and oil engine plant, and also between coal-fired and coal- and oil-fired steam stations. The oil-engined stations and the coal- and oil-fired steam stations naturally show the lower consumptions per unit. In the case of steam stations where more than one type of fuel is fired, the total fuel is expressed in terms of coal equivalent, the other fuel being equated to coal on the basis of the relative calorific values of the coal and other fuels actually fired at the station. Where, however, the stations are only fired with coal, no allowance is made for calorific value. In 1947, although the average calorific value (gross as fired) of all the coal consumed was 10,950 British Thermal Units per pound, 10 per cent. of the coal consumed had a calorific value of over 12,300 B.Th.U./lb., while 10 per cent. had a value of less than 9,400 B.Th.U./lb. It will be appreciated, therefore, that the weight of fuel consumed per unit is of limited value in comparing the fuel efficiency of different stations, or even of the same station in different years.

A better measure of fuel efficiency is the figure of thermal efficiency given for each station in the *Report on Generation of Electricity in Great Britain*, and also nationally in the Ministry's *Statistical Digest* for 1948 and 1949. This is the total heat value of the units sent out (one unit being taken as equivalent to 3,412 B.Th.U.), expressed as a percentage of the total calorific value of the fuels fired as reported by the stations.

Labour

The labour statistics for the electricity supply industry are less elaborate than those for some other industries, such as the coal industry. This is not altogether surprising, because wages and salaries account for only about a sixth of the total works cost of generation, and the importance of the technical factors affecting plant efficiency makes it hard to attach as much significance as in other industries to figures of output per man. Moreover, the development of the industry has been little hampered by unhappy labour relations. The Electricity Commissioners' labour statistics were confined to annual figures of the staff and workmen employed at the end of the year in operating and maintaining the undertakings, the total being subdivided, up to the commencement of the Second World War, into generation, distribution, and administration. The Commissioners also showed the total salaries and wages paid and charged to revenue account. More detailed information about the age, sex and functional composition of the labour force (including personnel at Area and headquarters offices), and the wages and salaries paid is published in the Ministry's *Statistical Digest* for 1948 and 1949.

As in the case of other industries, the *Ministry of Labour Gazette* gives monthly information about employment in the industry and half-yearly statistics of average earnings. These employment figures are based on the number of insurance cards exchanged in July, 1948, the persons currently recorded as unemployed or unfit for work, and the changes in the numbers employed at the end of each month shown by returns made to the Ministry of Fuel and Power. The statistics of earnings are based on a return to the Ministry of Labour showing the number of wage-earners actually at work in a particular week and the total wages paid to them.

Financial Statistics

The *Returns of Engineering and Financial Statistics* provide a continuous and comprehensive account of the financial position of the industry before nationalization. The capital accounts, which also include details of the capital raised (loans raised in the case of local authority undertakers), and of the position of sinking fund and other balances, are of special interest for the detailed description they give of the undertakers' capital expenditure on generation, main transmission, distribution, apparatus on consumers' premises, etc. For each year figures are given of the total to date of the original expenditure on all existing capital assets, the figures referring to the

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net total chargeable to capital account at the end of the year after allowing for gross expenditure chargeable to this account during the year, less any expenditure written off during the year. The figures of capital expenditure include expenditure met from revenue or reserves, the value of land appropriated, and expenditure in process of liquidation over a period of years such as the cost of changes of system, hire purchase balances, etc.

TABLE 2

Classification of Authorized Electricity Undertakers According to Expenditure Charged to Capital Account at End of Year 1947–1948(*a*)

	Number of Undertakers	*Total Capital Expenditure at End of Year*			*Units Sold during Year (b)*			*Capacity of Plant Installed at end of Year*
		Total	*Generation*	*Other*	*Sales to Central Electricity Board*	*Other Bulk Sales*	*Sales to Consumers*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		£ *Million*			*Million units*			*Megawatts*
Public Authorities								
Under £1 million	253	70·7	7·2	63·5	137	222	4,810	281
£1 million and up to £10 million	101	295·0	120·6	174·4	13,589	2,228	11,609	5,026
£10 million and over	8	128·8	60·5	68·3	8,595	1,174	5,252	2,578
Total	362	494·5	188·3	306·2	22,321	3,624	21,671	7,885
Companies								
Under £1 million	138	30·1	2·7	27·4	14	341	1,495	75
£1 million and up to £10 million	42	140·3	42·8	97·5	4,983	2,218	6,754	1,649
£10 million and over	9	160·9	67·3	93·6	11,273	4,248	5,823	3,222
Total	189	331·3	112·8	218·5	16,270	6,807	14,072	4,946
Central Electricity Board	1	74·6	3·3	71·3	—	38,162	240	120
Total (All undertakers)(*c*)	552	900·4	304·4	596·0	38,591	—	35,983	12,951

(*a*) Total of original capital expenditure on existing assets.
(*b*) The relationship between the figures in these three columns, which contain a large measure of duplication, is explained on pp. 514–516.
(*c*) Excluding four undertakers who did not exercise their statutory powers, and another four whose undertakings were operated by other undertakers.

Table 2 makes use of these figures to analyse the industry according to ownership and the total capital expenditure by each undertaker by the end of the financial year 1947/48. The large number of relatively small undertakers—particularly among the local authority undertakers—is striking. These small undertakers were largely engaged in distributing electricity which they obtained in bulk from the larger undertakers, either through the medium of the Central Electricity Board or direct.

The nature of the Commissioners' revenue account statistics can be indicated with the help of the following classification of all the main items involved:

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Revenue

A. Revenue from disposal to C.E.B. of energy generated under their direction.

B. Revenue from other operations:
1. Sales to consumers.
2. Bulk supplies to C.E.B. (other than any under A).
3. Bulk supplies to other authorized undertakers.
4. Rentals—
(*a*) Meters.
(*b*) Appliances.
(*c*) Wiring.
5. Other revenue.
6. Total of items B.1–5.

Expenditure

C. Costs of generation under direction of C.E.B.:
1. Working costs.
2. Overhead charges.

D. Expenditure on other operations:
1. Working costs of independent generation.
2. Energy purchased—
(*a*) From C.E.B.
(*b*) From other authorized undertakers.
(*c*) From outside sources.
3. Local rates.
4. Other expenses chargeable to revenue.
5. Total of items D.1–4.

Gross Surplus

1. Surplus of B.6 over D.5.
2. Gross interest and/or dividends received and receivable.
3. Allowances for capital charges on generation account in transactions with the C.E.B.
4. Other income.
5. Gross surplus (total of items 1–4).

The working costs of generation, C.1 and D.1, are very usefully given in detail under the separate headings of fuel, salaries and wages, repairs and maintenance, and oil, water and stores. The first of these includes not only the amounts paid for fuel, but the cost of handling, preparation and storage, flue gas treatment, ash disposal and steam purchased, and it should be noted that the second heading excludes salaries and wages charged against fuel and repairs and maintenance. The overhead charges C.2 are also subdivided.

Individual undertakers being regarded by the Commissioners as commencing their operations with a supply of energy purchased from the Central Electricity Board, together with any supplies generated independently or purchased from outside, their total revenues from working and total working expenses as presented by the Electricity Commissioners cover B and D only. Although the working costs of generation on behalf of the Central Electricity Board are separately shown in the published returns (usually in italics), they are not included in arriving at the surplus on revenue account of individual undertakers. Nor is the revenue accruing from disposals of this electricity shown. This part of the undertakers' business could not, of course, be entirely ignored, and it was brought in by the Commissioners by adding allowances for capital charges on generation account in transactions with the Board in calculating the gross surplus on revenue account. The figures for the two separate groups of public authorities and companies are treated in the same way. In arriving at the national totals for all undertakers, transactions between the Board and other authorized undertakers are excluded, the expenditure side of the account includes the total working costs of generation, whether the stations are operated independently or under Board control, and it excludes all purchases from the Board. Similarly, the revenue side of the account excludes all proceeds from sales to the Board and, in arriving at the gross surplus, allowances for capital charges in respect of generation under the direction of the Board are disregarded.

Other transactions between undertakings besides sales to and purchases from the Board are treated in the revenue accounts in the same way as they are in the calculation of total availability for sale—that is, they all appear in the figures for individual undertakers, while for the two groups of public authorities and companies, inter-sales within each group are excluded, and for the national totals all transactions which are internal to the industry are excluded except to the extent that inter-purchases exceed or fall short of inter-sales.

The main changes in definitions in the 25-year run of the Commissioners' financial statistics occur in their return for 1932/33. These affect in particular the subdivision of capital expenditure and the classification of the smaller items on revenue account, such as repair and maintenance of meters and apparatus. Again, before this issue, income tax is included as an item of expenditure on revenue account, but for 1932/33 and later years it is shown instead as one of the items of appropriation of the gross surplus on revenue account.

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The *Annual Reports and Accounts* of the British Electricity Authority and Area Boards give detailed financial information, which naturally covers much the same broad subject-matter as the Commissioners' financial statistics. For some items—such as generation works cost—broad comparisons may be made, after adjusting for the exclusion of the North of Scotland, between the two sets of information. But for most items comparison is made difficult or entirely invalidated by the change in the organization of the industry and by the adoption of new methods of accounting. Thus most of the figures for separate Area Boards, other than their sales of electricity to consumers, bear little relationship to those for the groups of authorized undertakings previously supplying the same area. The figures of bulk sales and purchases within the industry have a considerably changed significance. Again, the Authority's and the Boards' valuation of their assets bears little relation to the Commissioners' totals to date of the original expenditure on existing capital assets; the former is based on the values shown in the books of the former undertakers (whatever the basis on which these values had been recorded) as reduced by depreciation and capital provisions.

Analysis of Sales

The main historical statistics of sales are the Commissioners' annual revenue account figures of sales of energy divided under the following heads:

(i) Lighting, heating and cooking.

(ii) Power (including accumulator charging and supplemental factory lighting supplies where not separately metered).

(iii) Public lighting.

(iv) Traction.

The number of units sold and the total revenue under these four heads yield an average revenue per unit which, in the absence of better information, is often used as a measure of price changes or differences. This may, of course, be misleading, particularly in comparing different undertakings, because variations in average revenue per unit may reflect, not a true difference in price, but differences in the proportions in which different kinds of tariff are used, the size of consumers and the nature of their demand. Thus, a low revenue per unit for power may only reflect the existence of large consumers taking energy at off-peak hours or at high voltages which do not need to be transformed down to low-tension supplies.

In 1931/32 the Commissioners included in their form of return an analysis of consumers, sales and revenue into—

(*a*) Domestic premises (divided into two-part or all-in tariffs and other tariffs or rates).

(*b*) Public lighting authorities.

(*c*) Traction undertakings (separating railways from other transport).

(*d*) Farms.

(*e*) Shops, commercial premises (divided into shops, offices, public buildings, hotels and other premises).

(*f*) Factories and other industrial premises (separating voltages up to 650 volts and over).

But all undertakers were not able to provide this information, and the statistics were never published by the Commissioners. The material collected was, however, analysed by the Central Electricity Board, which made estimates of the total sales under each main head, and also carried the estimates back to earlier years. These figures are published in the Ministry of Fuel and Power's *Statistical Digest*. For 1948 and subsequent years this analysis is called for on a comprehensive national basis in the Ministry's returns.

GAS

Coal is carbonized by heating it in retorts or ovens out of contact with air; the volatile products are distilled from the coal and recovered as gases and liquids, and coke is left as a carbonized residue. In the year 1949 over 48 million tons of coal were treated in this way, 18 million tons more than the quantity of coal burnt by the electricity supply industry, and about a quarter of

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the country's total inland consumption of coal. In 1949 about half-a-million tons was dealt with by low temperature carbonization plants, in which the retorts are heated to not more than about 650° C., and the main object is production of a reactive smokeless semi-coke suitable for domestic use. The bulk of the tonnage is treated by high temperature carbonization in coke ovens and gas works, the coal being heated to temperatures of over 1,000° C. In 1949, 22½ million tons were carbonized by the coke-oven industry, where the principal object is the production of hard coke suitable for metallurgical use. The remaining 25 million tons were carbonized by the gas industry—with which the present paper is mainly concerned. The nature of the process in the gas industry is the same in principle as in the coke-oven industry, but different types of coal and plant are used and the main aim is to obtain the maximum yield of gas for public supply.

The gas works retorts are normally heated by producer gas made by passing a mixture of air and steam through a bed of incandescent coke. In addition to coal carbonizing plant, the gas works have plant for the manufacture of other types of gas, and in particular blue water gas and carburetted water gas. The former is made by alternately blowing air through a bed of coke to raise it to a high temperature and then passing steam through it. Carburetted water gas is made by mixing blue water gas with hydrocarbon gases produced by cracking gas oil, and because its output and calorific value can be readily adjusted to meet changes in demand, its production has largely replaced that of blue water gas and plays an important part in present-day gas-works practice. The coke-ovens are heated by coal gas, blast furnace gas or producer gas, and surplus gas is sold direct to consumers in the iron and steel and other industries and to the gas works, which, in turn, sell it to the public.

The coal gas and other products of coal carbonization must have been noted at an early date, because the dry distillation of organic materials constituted some of the more successful experiments of the early alchemists. Moreover, attempts had been made as early as the sixteenth century to produce coke suitable for replacing charcoal in smelting iron, and primitive ovens for the commercial production of coke and tar were in operation in the eighteenth century. In 1812 the first statutory gas company began to make "inflammable air" and distribute it for lighting. By 1882—when the first electricity supply undertakings were being formed—there were 500 statutory gas undertakings carbonizing 7 million tons of coal and supplying nearly two million consumers. In most cases these undertakings received their powers by means of Special Acts, Provisional Orders or Special Orders. Besides giving them powers to acquire land, construct works and break open highways, and requiring them to give and maintain supplies subject to certain conditions, these Acts and Orders usually contained clauses compelling them to prepare and make available for inspection proper accounts of their receipts and expenditure. The Gas Works Clauses Act of 1847 made such a clause standard practice. Parliament interested itself in the development of gas undertakings, and the Returns which it called for from an early date laid the foundations of the long series of official statistics for the industry.

These statistics fall into four chronological groups commencing with the period 1820–1865. During these years Parliamentary interest was largely concerned with the protection of consumers against abuses. After 1840 it was usual for the rate of dividend payable by companies to be limited, and after 1845 these provisions were frequently supported by clauses prescribing a maximum price for gas. In 1847 a Return to an address of the House of Commons was published giving an abstract for the years 1820–1846 of information collected for every gas undertaking established by Act of Parliament in the United Kingdom. From then to 1865 a Return was published annually. These Returns record for each undertaking the Act of Parliament under which it was established, the rates per 1,000 cu.ft. at which it supplied gas, the price of coal (price of best coal before 1847), the amount of fixed capital, and the rate per cent. of the dividends paid. The Returns do not give aggregated figures for all the undertakings covered.

The second period is 1880–1920. During the preceding interval, when official publication appears to have been discontinued, considerable developments had taken place in the industry, particularly on the technical side. Mackintosh's experiments in waterproofing by dissolving rubber in coal tar naphtha, the railway demand for creosote for wood preservation, patents for using tar in road-making and pitch in briquetting, Perkins' discovery of the aniline dyes, and Lister's use of carbolic acid as a disinfectant, had all begun to reveal the chemical and industrial treasures contained in coal by-products, the disposal of which had previously presented difficulties. Of still greater economic importance, fireclay retorts had been introduced which could be heated

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to higher temperatures than the iron retorts previously employed and gave a greatly increased yield of gas; the Bunsen burner had made possible the extended use of gas in addition to its hitherto predominant use for lighting; the Otto gas engine had shown the possibilities of its use for power; and the introduction of the first schemes for hiring cookers had pointed the way to the commercial development of the domestic cooking load. Further technical developments took place during the period. Exploration of the chemical and industrial possibilities of crude tar and other by-products proceeded, and an invention of great economic significance was the incandescent gas mantle, developed in the last decade of the nineteenth century, which made the lighting-power of the gas dependent on its capacity to heat the mantle rather than on its own luminosity, and which produced an equivalent amount of light for a fraction of the previous gas consumption. Legislation helped to consolidate the position of the industry. Following the Metropolitan Gas Act of 1860, increasing numbers of undertakings were given monopoly powers. The Gas Works Clauses Act of 1871 prescribed standards of quality, purity and pressure, and standardized the obligation to supply, and in 1875 the defects in the maximum price and dividend regulations began to be remedied by the introduction of sliding scale clauses which sought to reconcile the interests of consumers and shareholders by making changes in dividends inversely dependent on changes in gas prices. One of the provisions of the Gas Works Clauses Act, 1871, obliged undertakers to maintain detailed accounts in specified form, and detailed information for 1880 was collected by the Home Office. The published Return for 1880 covers only companies established in England and Wales; the Returns for the following year cover local authorities in England and Wales as well. For the years 1882 to 1920 the Returns give details for each authorized undertaking in the United Kingdom with accompanying national summaries. These details include the quantities of coal carbonized, other materials used, gas made and sold to private consumers and for public lighting, and the prescribed and actual illuminating power of the gas. The public concern about price and dividend limitation is reflected in the details given about prices authorized and charged, the amount of capital or loans raised and the dividends paid. The only substantial changes in these Returns made during the period were the addition of particulars of the use of water gas and of receipts and expenditure on revenue account.

The beginnings of the third period of official gas statistics, 1921–1947, are to be found in the Gas Regulation Act, 1920. By this date the industry comprised 798 statutory undertakers and had seven-and-a-half million consumers; it carbonized nearly eighteen million tons of coal per annum, and had a large heating load. The Act of 1920 was directed mainly to the introduction of the thermal instead of the volumetric basis of charge, and the imposition of obligations for the maintenance of pressure, purity and calorific value. It also required undertakers to furnish annual accounts and statistics to the Board of Trade at such times and in such form as might be directed. The Board used these powers to prepare and publish its *Return relating to all Authorized Gas Undertakings in Great Britain*. This followed closely the lines of the earlier Returns to Parliament. The main points of difference are the exclusion of Ireland, the substitution of details about the calorific value of the gas sold for particulars of its illuminating power, and the addition of information about bulk sales between undertakings, bulk purchases from the coke ovens, and the make of crude tar, coke and sulphate of ammonia. The *Returns* for 1938–1944 were published in a composite volume by the Ministry of Fuel and Power, and were noteworthy for the inclusion for the first time of official statistics for non-statutory undertakers. The larger of these had had statutory duties and powers imposed upon them by the Gas Undertakings Act of 1934, and those that remained non-statutory had been required by the same Act to render an annual return of gas supplied. In the 1947 Return the particulars for non-statutory undertakers were given in the same detail as those for statutory undertakers. Both the 1947 and the composite Return for 1945 and 1946 were also noteworthy for their detailed analysis of gas sales. The financial part of the Return was last published in respect of 1937, although some financial statistics for 1945 were given in the Ministry of Fuel and Power's *Statistical Digest* for 1946 and 1947. The part of the Return dealing with the manufacture and supply of gas came to an end with the issue for 1947.

For 1948 the statutory annual forms of return for the gas industry were revised by the Ministry of Fuel and Power and, so far as the special conditions of the industry permitted, were made comparable with the annual forms of return for the other fuel and power industries and with the schedules of the Census of Production Office. Besides information similar to that previously

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obtained about manufacture and supply, the new returns ask for details of wages and salaries payable, capital expenditure, materials purchased, and the value of output and other work done. The resulting statistics are published in the Ministry's *Statistical Digest* for 1948 and 1949 in a form appropriate to the new organization of the industry resulting from the Gas Act, 1948, although this organization did not take effect until May 1st, 1949. Under the provisions of the Act the assets of undertakers mainly engaged in public gas supply vested on May 1st, 1949, in twelve Area Gas Boards and the Gas Council. The statistics for the industry published in the Ministry's *Statistical Digest* now distinguish between vested and non-vested undertakings, and not, as previously, between statutory and non-statutory. The geographical classification used relates to the Gas Board Areas, and its nature is illustrated by the maps in the *Digest*.

The Area Gas Boards are responsible for the development and maintenance of an efficient, co-ordinated and economical system of gas supply and gas coke production. The Gas Council comprises, in addition to its Chairman and Vice-Chairman, the twelve Chairmen of the Area Gas Boards, and is responsible for issuing British Gas Stock, maintaining control over the Area Boards with regard to certain financial and other matters, advising the Minister on questions affecting the industry, and assisting the Boards in various ways—for example, research, training and education of personnel, and where necessary, the manufacture and supply of plant and fittings. An obligation is placed upon each Area Gas Board and upon the Gas Council to afford the Minister facilities for obtaining information, including such returns and accounts at such times and in such manner as he may reasonably require. The statistical information for the industry is now obtained by the Ministry from the Gas Council and the Area Gas Boards. The Act of 1948 also provided that each Area Board and the Gas Council must render Annual Reports and Statements of Accounts to the Minister dealing with the performance of their functions during the year, the Minister being empowered to give directions as to the form of the Reports and Accounts. When, in due course, these are published, they can be expected to give valuable information about the industry, including statistical and financial data supplementing those published by the Ministry.

The coke oven industry, although it started earlier than the gas industry, developed more slowly. Notwithstanding its waste of gas and other by-products, the primitive bee-hive oven achieved its main purpose of producing metallurgical coke of good quality, and its cost was low. It was not until 1882 that the first battery of modern coke-ovens equipped for the recovery of by-products was installed, and even then the by-product ovens did not make rapid headway against the bee-hive oven until the beginning of this century. In 1900 the by-product ovens accounted for only 7 per cent. of the make of hard coke, but in 1918 for 78 per cent. Coke-oven gas was first supplied to outside consumers in 1906, and in 1918 the Sheffield Gas Company began to take coke-oven gas. Official statistics for the industry showing the number and type of ovens in operation and the amount of coke made began to be published in 1905 in the Home Office publication *Mines and Quarries General Report and Statistics*. After 1920 these statistics were continued in the *Reports of the Secretary of Mines*, and later in the Ministry of Fuel and Power's *Statistical Digest*. The last two publications are also the source of information about the low temperature carbonization industry.

So far regard has been had to the annual statistics, but the development of short-term statistics must also be mentioned. In 1940 the Mines Department began to collect, for purposes of solid fuel programming, weekly returns from the gas works and coke ovens, and from consumers of coal and coke. When the Central Statistical Office's *Monthly Digest of Statistics* was first published at the beginning of 1946, it included particulars of the gas made at gas works, the consumption and stocks of coal at gas works and coke-ovens, and the make of coke, and since then these particulars have been extended. In addition, weekly statistics of the total gas available at gas works, including purchases of coke-oven gas, are now published in the Ministry's *Weekly Statistical Statement*.

Definition of the Gas Industry

The gas industry (which excludes the coke-oven and low-temperature carbonization industries) was divisible before nationalization as follows:

(i) Statutory gas undertakings—sometimes referred to as authorized gas undertakings. These were the undertakings with statutory powers to engage in the business of public

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supply. In 1948 they consisted of 402 companies who sold 279,679 million cu. ft. of gas, and 275 local authorities who sold 174,198 million cu. ft. The main series of official statistics for the gas industry up to 1948 relates to these undertakings only.

(ii) Non-statutory undertakings. These were company undertakings which were mainly engaged in the supply of gas to the public and did so without the authority of any enactment. In 1948 they numbered 361 and sold 9,601 million cu. ft. of gas. Separate particulars for them are given in post-war issues of the *Return relating to Gas Undertakings in Great Britain* and the *Statistical Digest* of the Ministry of Fuel and Power. They have always been included, with the statutory undertakers, in the weekly and monthly statistics for the industry.

(iii) Other undertakings for whom the manufacture and supply of gas was not the main part of their business. Where they supplied most of their gas to the public they are referred to in the Gas Act, 1948, as ancillary gas undertakers. The weekly and monthly statistics which are derived from the solid fuel programming returns include certain of these undertakers, whose total make of gas was 0·4 per cent. of the total make by statutory and non-statutory undertakers.

On nationalization the statutory and non-statutory undertakings vested in the Area Gas Boards and Gas Council, along with gas-holding companies and certain ancillary gas undertakings which were not exempted on the ground of the special character of their business. Nationalization has not affected the coverage of the short-period statistics for the industry. So far as the annual statistics are concerned, the reports and accounts of the Gas Council and Area Gas Boards can be expected to cover the field of the vested undertakings. The *Statistical Digest* of the Ministry for 1948 and 1949 shows figures for the same field and for the gas works of railway and transport undertakings, and a few of the tables are based upon the weekly returns with their slightly wider coverage.

Since 1920, when the *Return relating to Authorized Gas Undertakings* still referred to the United Kingdom, the official statistics for the industry have related to Great Britain only.

Periods of Time Covered

The short-term statistics, being based on weekly returns, relate either to weeks or to periods of four or five weeks. At the end of each year the *Weekly Statistical Statement* gives 52-week figures. The figures for years given in the *Monthly Digest* of the Central Statistical Office are estimates for 365 or 366 days.

With the exception of a few undertakings, the annual statistics for the manufacture and supply of gas have always related to calendar years. The annual statistics for financial matters have in the past related to the financial years of the undertakings, namely, the calendar year in the case of company undertakings, the year ending March 31st in the case of local authorities in England and Wales, and that ending May 15th in the case of Scottish local authorities. The reports and accounts of the Gas Council and Area Gas Boards are expected to relate to their financial year, which ends on March 31st (the first year of operation being one of eleven months). The *Statistical Digest* of the Ministry of Fuel and Power for 1948 and 1949 relates as far as possible to calendar years throughout.

Capacity

No regular statistics have been published about the physical capacity of gas works plant, and the only light on the extent and nature of the industry's capacity thrown by published official statistics is given in the table in the Ministry's *Statistical Digest* that shows the consumption of fuel in recent years classified according to the nature of the gas-making process, and in the other tables that show, for each separate type of gas, the maximum make in any one week of each winter.

The following details, based on a special return of the position at December 31st, 1946, are not without interest:

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TABLE 3

Age and Capacity of Gas Plant at the End of 1946

Million cubic feet.

Date of Construction	*Total Capacity of Gas Holders*	*Effective Daily Capacity of Gas-making Plant*									
		Carbonization									
		Horizontals	*Continuous Verticals*	*Intermittent Verticals*	*Other Carbonizing Plant*	*Total*	*Carburetted Water Gas*	*Blue Water Gas*	*Producer Gas Plant for Dilution Purposes*	*Other*	*Total all Gas-Making Plant*
Unknown	20	29	—	—	1	30	4	—	1	1	36
Before 1900	497	46	—	—	—	46	13	—	—	—	59
1900–1919	239	162	87	8	3	260	64	3	28	—	355
1920–1929	201	137	216	8	2	363	119	5	3	3	493
1930–1946	369	141	365	73	18	597	208	7	24	9	845
Total	1,326	515	668	89	24	1,296	408	15	56	13	1,788

These figures not only show the large proportion of carbonizing capacity still represented by horizontal retorts, but also the advanced age of a great deal of the industry's plant.

Gas Made, Available and Sold

Since 1920 it has been obligatory for nearly all authorized gas undertakers to charge on a heat unit basis, to declare the calorific value of their gas, and to maintain this standard. The heat unit of measurement and the basis of charge for gas supplies is the therm, which is equivalent to 100,000 British Thermal Units. The calorific values declared by different undertakers in 1948 varied considerably between 200 and 600 B.Th.U. per cubic foot of gas, but the average calorific value of gas sold was 468 B.Th.U. per cu. ft.

The annual returns for the industry ask for figures in terms of cubic feet as well as therms; the short-period returns ask for cubic feet only, although in the *Monthly Digest of Statistics* the total availability of gas is given in therms with the help of the average thermal values shown by the annual returns.

Before the war the definition of gas made was not precise, but this was altered in the annual form of return for 1946. Since then the annual returns have referred to the total make of gas by carbonization and by other gas-making processes, excluding producer gas made for firing the retorts. They have asked for the figures to be corrected to a standard pressure of 30 inches of mercury and a standard temperature of 60° F. Moreover, it is specified that the gas made should be measured on the basis of its being saturated with water vapour and before benzole extraction. Where metering does not precede extraction, adjustment has to be made for the amount of benzole extracted. In 1948 the total make of gas before benzole recovery was 2,118 million therms. The amount of crude benzole extracted was 24·4 million gallons, and since a gallon of crude benzole has a heat content of about 1·5 therms, it will be seen that measurement of the make of gas before benzole extraction increased the recorded thermal value of the make of gas in that year by about 1·8 per cent. above what was actually made for sale. In the case of the short-period statistics based on weekly solid fuel programming returns the method of measurement is not precisely defined, and the figures obtained are not as accurate as those yielded by the annual returns.

In the figures for each individual undertaker given in the *Return for Gas Undertakings*, the total availability of gas is its own make plus its purchases from coke-ovens and other establishments outside the industry plus its purchases from other gas undertakers. Its sales, however, are limited to its direct sales to consumers and exclude sales to other gas undertakers. In the national totals both the purchases from and sales to other gas undertakers (which are much less substantial than similar transactions in the electricity supply industry) are excluded from the figures of total availability and sales; no allowance is made, as was made by the Electricity Commissioners, for any differences between inter-purchases and inter-sales. Thus, the national total

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availability is the total gas made by gas works plus the industry's purchases from the coke-ovens and other outside sources. The difference between it and total sales to consumers reflects distribution losses due to leaking pipes and other causes, differences in temperature and pressure conditions between the measurement of make and sales, benzole extraction and consumption in the undertakers' own premises. For individual undertakers the difference between availability and sales reflects also any gas sold to other gas undertakers.

Roughly half the yield of gas at coke ovens is used at the ovens, about a quarter is disposed of to gas works, and a further quarter is disposed of direct to consumers, mainly collieries and iron and steel plants. Only a small proportion is now bled to waste.

Fuel Consumption and Yields of Gas

The *Statistical Digest for* 1948 *and* 1949 gives the consumption of different types of fuel in each type of gas-making process, together with the resulting yields of gas. The tonnages of coal, coke and oil consumed as raw materials in the gas-making process are distinguished from those used as fuel for ancillary purposes, such as boilers, locomotives, cranes, by-product plants and showrooms. This information shows that, in 1948, the carbonization of one ton of coal produced 14,760 cu.ft. or 72·5 therms of gas (before benzole extraction). It also yields the following table, which shows the total make of each main type of gas, and also the amounts of fuel that had to be consumed in order to obtain the same thermal output of gas as was obtained from the carbonization of one ton of coal:

TABLE 4

Make of Gas and Fuel Consumed per 72·5 *Therms made in* 1948

	Total Make of Gas (Mil. therms)	*Consumption of Fuel per 72·5 Therms Made*			
		Coal	*Coke*	*Coke breeze*	*Oil*
		(*Tons*)			
Coal gas (1)	1,762·4	1·000	—	—	—
Water gas (2)	327·1	0·001	0·283	0·009	0·099
Producer gas (3)	18·2	0·328	0·129	0·004	—
Oil gas (4)	3·6	—	—	—	0·331
Other (5)	7·0	0·559	0·052	—	0·005

(1) Average of all gas made by different types of coal carbonizing plant.
(2) Blue and carburetted water gas.
(3) Excluding producers making gas for firing retorts.
(4) Gas made by oil gasification.
(5) Gas from Tully gas plants, tar gas plants and all other gas-making processes. Some of these used other fuels besides those shown above.

At coke-ovens the yield of gas is approximately 10,900 cu. ft., or about 55 therms per ton of coal carbonized and, as already explained, much of this is consumed at the ovens.

The statistics based on the weekly solid fuel programming returns refer, not to the coal carbonized at gas works, but to the total used, including consumption for ancillary purposes, such as in locomotives and cranes, or for heating show-rooms. For the coke-ovens, however, they refer only to the coal carbonized.

Coke

The coke made at gas works is usually referred to as gas coke, and that made at coke-ovens as hard or metallurgical coke. The latter is divided into foundry and furnace coke, according to its suitability for these two uses. The output of the coke-ovens operated by the gas industry in the London area is included in the gas works production of coke in the Ministry's *Statistical Digest*.

Small coke of sizes below about ½ in. is referred to as coke breeze. It constitutes about a tenth of the total yield of coke, but a substantial part of this is used in the gas works. It is

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included with coke in certain statistics—for example, in the *Return Relating to Gas Undertakers*—but is more generally either excluded, as in the *Monthly Digest of Statistics*, or shown separately.

The yield of coke at gas works is of the order of 0·7 tons per ton of coal carbonized, but exact figures are not available. A considerable part of the total yield is used for heating the retorts, and in 1948 a further 0·08 tons of coke per ton of coal carbonized was used for making water gas and for other gas works consumption, leaving 0·37 tons of coke (excluding breeze) available for sale per ton of coal carbonized.

Other By-products

As the crude gas leaves the carbonization chambers, the tar and aqueous vapour accompanying it are largely removed by condensation. The remaining tar fog and the other impurities contained in the gas, such as ammonia, hydrogen sulphide, naphthaline and hydrocyanic gas, are removed to enable the gas to comply with statutory requirements. Benzole may either be left in the gas or extracted from it. These processes give rise to valuable by-products, including ammonium sulphate and spent oxide, and the crude tar and crude benzole are the starting-points for distillation and refining processes of great chemical and industrial significance.

The theoretical yield of the crude benzole stripped from the gas and obtained from the naphtha and light oil distilled from crude tar is about 3 gallons per ton of coal carbonized, but extraction is considerably less complete in the gas industry than in the coke-oven industry. In 1948 the amount of benzole extracted per ton of coal carbonized at gas works and coke ovens amounted to 1·9 gallons, and of this, a little over half was made into motor benzole, the remainder being made into refined benzole, toluole, xylole, and solvent and heavy naphthas. These products, besides being used for making paints, varnishes, inks, perfumes, rubber solvents, etc., give rise to a number of further chemicals and commercial products, ranging from saccharin to butadiene.

The yield of crude tar varies around 14 gallons per ton for continuous vertical retorts, 10 gallons per ton for horizontal retorts, and 9 gallons per ton for coke-ovens, and the total crude tar sent for distillation in 1948 represented 5·2 per cent. by weight of the total quantity of coal carbonized in the gas and coke-oven industries. The two main bulk constituents, creosote and pitch, constituted 34 per cent. and 54 per cent. respectively of the total distilled. Mixtures of these products in the proportion of about 30 parts of creosote to 70 parts of pitch constitute refined and road tar, and mixtures in about the proportions 45:55 form the creosote/pitch mixtures used for burning purposes as an alternative to fuel oil. Besides these bulk products, crude tar yields refined products of the greatest significance to the chemical industry—pyridine, phenol, naphthalene, anthracene, etc., as well as the benzene and toluene contained in the naphtha and light oil. These have widely varying applications in the synthesis of a vast series of dyes, drugs, perfumes, antiseptics, plastics, photographic chemicals, explosives, etc.

Many of the larger gas works and coke-ovens operate their own tar distilleries and benzole refineries, and where they do so, these plants are included in the statistics of employment, capital expenditure, output, etc., for the gas and coke-oven industries, published in the *Statistical Digest* of the Ministry of Fuel and Power.

Tar distillation and benzole refining are also carried out by private companies which buy their raw material principally from the gas and coke-oven industries, and dispose of their products either to the final consumers or to the chemical industry for further treatment. The tables in the *Statistical Digest* deal with the distillation and refining operations both of these companies and of the gas works and coke-ovens. While these and the tables in the sections of the *Digest* dealing with the gas and coke-oven industries show the most important products produced by these industries, the statistics for the ultimate products are, of course, largely the statistics of the chemical industry. Additional information about the by-product industries will be found in the *Annual Reports on Alkali, etc., Works*.

Labour

Information about the number and earnings of persons employed in the gas industry is published by the Ministry of Labour in a similar form to that for the electricity supply industry. Until 1943 the annual returns for the industry did not include information about this subject, but the Ministry's *Statistical Digest* has given figures for that and subsequent years, together with

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the results of a special census covering 1939. These figures refer to all persons employed at gas works (including administrative, technical and clerical workers) cross-classified by occupation and sex. The *Digest* for 1948 and 1949 gives further information about the numbers aged under 18, and 18 and over, in the week ended September 25th, 1948, the numbers engaged on certain special types of work, the numbers of operatives employed at the end of each month of 1948, and the total wages and salaries paid. For the coke ovens the monthly statistics in the *Ministry of Labour Gazette* compare with those for other industries covered by the Ministry of Labour's own returns. Annual figures—in some detail—are given in the Ministry's *Digest*.

Financial Statistics

The financial statistics for the gas industry before nationalization are limited to a comparatively small number of items, which were most relevant to the control exercised by Parliament over the capital raised, dividends paid, and prices charged. There are no figures of capital expenditure by the industry on existing assets, such as those for the electricity industry. There are only figures of the share and stock capital authorized and paid up and of the loan capital authorized and issued. For local authorities the comparable information available refers to the total value of the loans authorized, the amount of money borrowed, the total amount of loans repaid, and the balances in sinking funds. In interpreting these figures, it must be remembered that they give a very limited picture of the real value of the industry's capital assets, and of its distribution between company and local authority undertakers. Thus, in the early days, the companies (and with the exception of Manchester, the early undertakers were all companies) were regarded as hazardous ventures, and were allowed to raise capital on a 10 per cent. basis, or 7½ per cent. for additional capital. As time went on and the industry established itself, these high yields enabled the companies to obtain large premiums by issuing shares above par and, with Parliamentary sanction, a large number of companies converted their capital on to a 4 or 5 per cent. basis, new capital being issued with this new rate of dividend and the old capital receiving an addition sufficient to maintain the original income. In this way the nominal capital was increased without a corresponding increase in real assets. On the other hand, while the capital on which interest was payable increased in company undertakings, it decreased in local authority undertakers, because, as companies were purchased by local authorities, the loans required for this purpose were only sanctioned on the understanding that they would be paid off through sinking fund contributions well within the estimated life of the plant. Thus, by 1945, for every 20 therms of gas sold, local authority undertakings had only £1 of outstanding debt, whilst statutory companies had £3 of share and loan capital.

Again, the figures for capital authorized and issued refer to the par value of the stocks. Accordingly, the best estimate of the amount of capital investment in the industry that the Heyworth Committee could make in its Report on the Gas Industry was obtained by increasing the outstanding capital of the companies by the 10 per cent. by which the market value of quoted stocks was above par, establishing the ratio of the resulting figure to company sales of gas, and applying this ratio to the total sales of gas by all undertakers, including local authorities.

Only the total receipts and expenditure on revenue account of the pre-nationalization undertakers are given in the published statistics; there have been no details of costs of production nor of proceeds from sales comparable to those published for electricity. But useful information has been published about the tariffs of individual undertakings. In studying these, and also the figures of dividends paid, it is necessary to be clear about the three basic methods of price and dividend fixing employed by the undertakers:

(i) *Maximum basic prices.*—Before nationalization, 14 per cent. of the gas made by statutory companies was made by maximum price companies. These were the oldest types of companies, and their Acts or Orders laid down maximum gas prices and maximum dividends, which they could not exceed without obtaining another Act or Order.

(ii) *Standard prices.*—Standard price or sliding scale companies, which accounted for 35 per cent. of the make of gas before nationalization, operated under provisions introduced in 1875, with the object of giving both consumers and undertakings a mutual financial interest in the economy and efficiency of the undertaker. Standard prices and standard

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dividends were fixed, together with a sliding scale whereby reductions in prices below the standard permitted increases in dividends above standard.

(iii) *Basic prices.*—The companies operating this system, which was first introduced in 1920, were mainly the larger ones, and accounted for 50 per cent. of the make by statutory companies. This system provided for basic (that is, minimum) gas prices and dividends. The difference each year between the total sum charged to consumers and what that sum would have been if the charge had been the basic price represented the "consumers' share"; a third of it was divided between dividends and the benefit of the employees of the companies and the remaining two-thirds was used to reduce the price of gas.

Analysis of Sales

The pre-1945 statistics of sales distinguish only between sales for public lighting, pre-payment consumers (consumers paying by means of a meter) and other sales. The number of consumers refers to the number of separate accounts, and the therms sold were calculated by multiplying for each undertaking the number of cubic feet sold by the declared calorific value and dividing by 100,000.

For 1945 and the following years the available analysis is defined as follows:

Domestic.—All premises used wholly or mainly for domestic purposes. Division is made into pre-payment and other.

Industrial.—This includes gas sold as a separate supply for industrial purposes in pursuance of the provisions of a special Act or Order. It also includes all premises, other than domestic premises, at which goods, commodities or articles are grown, manufactured, produced, processed and/or repaired for profit; farms and horticultural premises, and mines and quarries, are included, and also Naval Dockyards, Royal Ordnance Factories, and railway workshops.

Commercial.—This includes shops, offices (other than Government offices), hotels, railway station lighting, etc.

Central Government Departments.

Local Government.

Public Lighting.

For 1946 and 1947 the returns asked for particulars of sales in excess of 50,000 therms per annum to industrial consumers, and the Ministry's *Digest* for these years gives a breakdown of these sales (which accounted for two-thirds of total industrial sales) according to nine industrial trades, for which coal statistics are also given in the *Digest.*

In addition to separate information about the disposals of each type of coke to different classes of consumers obtained from returns from the industries themselves and published in its *Statistical Digest*, the Ministry's solid fuel programming returns provide information, which is also summarized in the *Digest*, about the receipts, consumption and stocks of coke (hard and gas coke together) for each main class of consumer. The definitions of the latter correspond broadly to the definitions of the coal consumption statistics. It may be noted, however, that the figure given for domestic consumption relates to merchants' disposals, including disposals to small shops, offices, factories and other non-programmed consumers, and it excludes approximately 1·5 million tons of coke supplied in small lots direct from the producers' works to consumers, most of them domestic consumers.

May 13th, 1950.

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The Sources and Nature of Statistical Information in Special Fields of Statistics

The Sugar Industry

By Philip Lyle

Introduction

It is not possible to confine a review of the sources of information concerning the sugar industry to the United Kingdom, as about 80 per cent. of the sugar used in this country for direct consumption, manufacture and export comes from overseas.

Although sugar is contained in the juices of most fruits, roots and grasses, the only commercial sources of importance are the Sugar Cane (grown in hot climates) and the Sugar Beet (grown in temperate climates). In each case, in the presence of chlorophyll, sunlight brings about the combination of carbon dioxide from the air and water to form sugar in the leaf, whence it finds its way to the stem or root for storage as a dilute juice. In each case, to save transport of bulky materials, factories, operating in the crop season, are provided near the cultivations, where the juice is extracted and purified and sugar is produced by crystallization, in most cases in the form of "raw sugar"—a brown sugar—which is sent to sugar refineries, situated near centres of population, for refining.

Molasses, a by-product of the manufacture and refining of sugar, contains about 50 per cent. of sugar which cannot be recovered economically as sugar, but can be converted into other products, e.g. alcohol. Very roughly 100 parts of raw sugar contain 95 parts of refined sugar and 5 parts of molasses.

Consumption figures usually refer to refined sugar, and production figures to raw sugar. All imports into the United Kingdom to-day are in the form of raw sugar. In 1938 about 5 per cent. of the imports were in the form of refined sugar.

The subject is dealt with below under three headings: I. Historical, II. Commercial, and III. Technical.

My acknowledgments for useful help are due to the Ministry of Food, H.M. Customs and Excise, The United Molasses Co., Ltd., The British Sugar Corporation, Ltd., Messrs. C. Czarnikow & Co., Messrs. Farr & Co., New York, and Messrs. Seccombe, Evans and Farradane of Tate & Lyle Ltd.

I. *Historical*

1. *General*

Until recently the standard historical work was von Lippmann's *Geschichte des Zuckers* (17), tracing the history of sugar from the earliest times and containing several thousand references, but available only in German. Within the last year Noel Deerr's *History of Sugar* (6) has appeared, and these two books cover the whole development of the cane and beet sugar industries very fully. Both these writers quote at length from the old work (in seven volumes) by Thorold Rogers, *The History of Agriculture and Prices* (25), from which, together with more recent records, we can trace the movements of sugar prices in the United Kingdom for nearly seven centuries.

2. *Prices*

A few earlier prices are given, e.g. in Jerusalem in A.D. 985 sugar was 1¼*d.* per lb., and in Morocco in 1068 1½*d.* per lb., but as the prices of other foodstuffs in those years and countries are not given we can form no opinion of the relative value of sugar as we can for later periods.

The approximate average retail prices of sugar in England are shown in Fig. 1 from 1259 onwards. It will be noticed that in 1500 the price was as low as 3*d.* per lb., and even in the 14th century it was only about 1*s.* 6*d.* per lb., although consumed only in very small quantities by rich people. Some idea of the relative values can, however, be obtained by comparison with the

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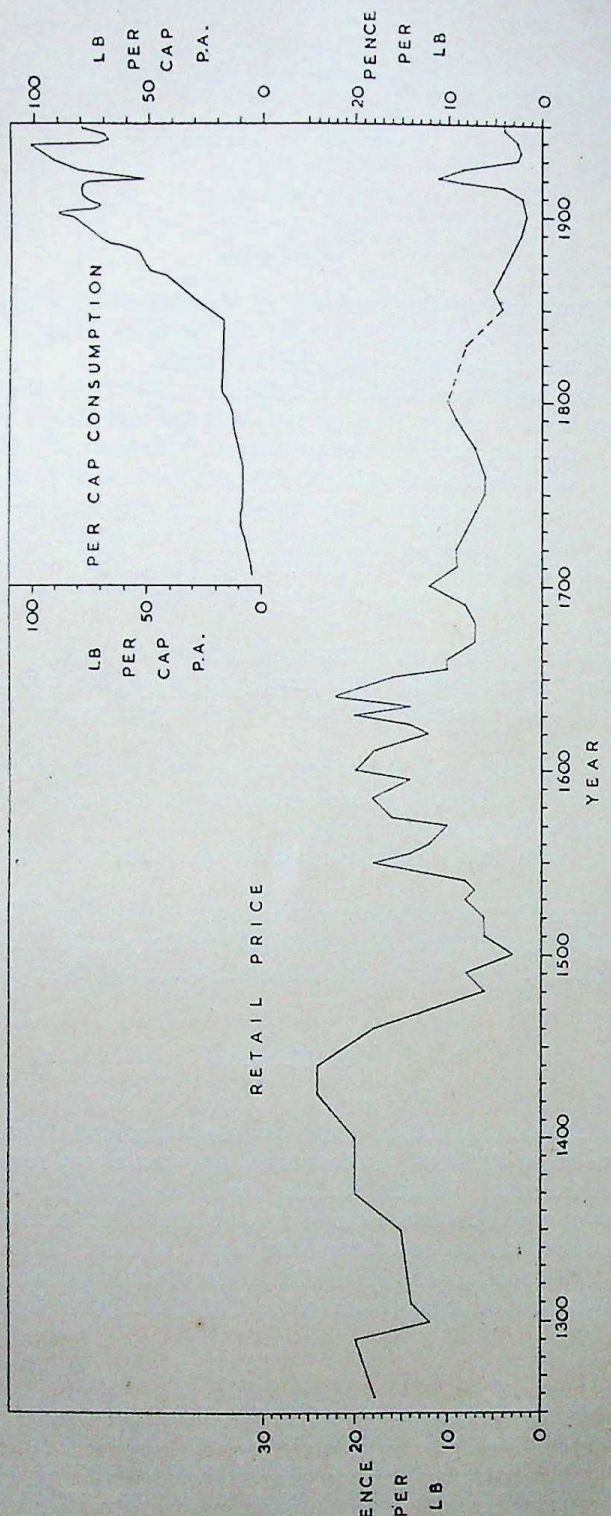
FIG. 1. RETAIL PRICES AND CONSUMPTION OF SUGAR. U.K.



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prices of other foodstuffs quoted by Thorold Rogers and Noel Deerr, and such a comparison is attempted in Table 1, which gives the amounts of cheese, butter, eggs and honey equivalent in value (retail) to 1 lb. of sugar for various periods between 1259 and 1702, and in the last row for prices quoted by Deerr as obtaining in Oxford in 1937. In the last column the approximate relative values of sugar are shown.

TABLE 1

Amounts Equivalent in Value (Retail) to 1 lb. of Sugar

Period	*Cheese*	*Butter*	*Eggs*	*Honey*	*Approximate Relative Value of Sugar*
1259–1400	28 lb.	29 lb.	34 doz.	—	150
1401–1540	20 ,,	11 ,,	19 ,,	12 lb.	90
1541–1582	13 ,,	7 ,,	6 ,,	7 ,,	45
1583–1702	3 ,,	5 ,,	4 ,,	—	20
1937	3 oz.	3 oz.	2 eggs	2½ oz.	1

3. *Consumption*

For periods before the 18th century no figures of sugar consumption appear to be known. In the 13th and 14th centuries sugar was a luxury classed with spices, and the amount imported was quite trifling. For instance, William Carew Hazlitt (12) tells us that sugar was clearly very scarce and doubtless equally dear when in 1226 Henry III asked the Mayor of Winchester to procure him three pounds of sugar of Alexandria "if so much could be got."

The approximate average consumption of sugar in the United Kingdom in lb. per head per annum since 1700 is shown in Fig. 1.

In 1938 the *per caput* consumption in the United Kingdom was 112 lb., and in the whole world about 25 lb.

4. *Duties*

Sugar has been subject to Customs duties from the earliest times, but before 1660 only as general merchandize subject to a 5 per cent. *ad valorem* duty. The first Customs duties specially enacted upon sugar were those set out in the *Book of Rates* in 1660. The duties continued with many variations until repealed in 1874, to be re-introduced in 1901. The history of the sugar duties is given fully by Noel Deerr (6) and Pittar (24).

The duty to-day (1950) is approximately 1*d.* per lb.

It is interesting to notice that in 1722 an Act (8 Geo. 1, Cap. 4) was passed disposing of a private right claimed by the proprietors of four "sugar houses" (refineries) in Scotland to be exempt from the payment of customs duties, which right appears to have been admitted, as the said proprietors are specifically indemnified from the payment of any duties previously claimed by H.M. Customs!

II. *Commercial*

1. *General*

The chief sources of commercial statistics relating to sugar will be found in Table 2, the rows covering the chief producing and consuming countries and the columns such items as production, consumption, crop reports, prices, etc. The numbers in the cells refer to publications detailed in the Bibliography, and give in each case the principal, though by no means the only, source of information.

2. *Supplies and Distribution*

In Table 3 an attempt has been made, for the years 1938 and 1949, to account for all the Sugar and Molasses produced in or imported into the United Kingdom. The imports shown in Table 3, and the home grown beet sugar production, are published (see Table 2), but the detailed figures

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TABLE 2

Sources of Information for Various Countries

Figures refer to Bibliography	*Production*	*Imports*	*Exports*	*Consumption*	*Consumption per caput*	*Stocks*	*Acreage—Beet*	*Acreage—Cane*	*Crop Estimates*	*Crop Reports*	*Crop Yields*	*Quotas, Consumption*	*Quotas, Export*	*Quotas, Import*	*Prices, Beet*	*Prices, Cane*	*Prices, Domestic*	*Prices, World*	*Agreements, International*	*Agreements, Trade*	*Sugar Companies*	*Sugar Mills, Refineries*	*Company Reports*	*Duties*	*Reviews, Economic*	*Taxes (on Sales, etc.)*
World . . .	111	107	107	107	58	107	—	—	111	—	111	—	127	—	—	—	—	127	—	—	—	—	—	—	111	—
Europe . . .	58	58	58	58	58	58	—	—	58	58	58	—	126	—	58	—	127	—	126	58	113	113	—	58	58	107
U.K. . . .	91	91	91	91	91	89	91	—	101	101	91	—	—	—	91	—	127	127	126	97	113	113	112	90	101	—
British Commonwealth .	111	95	95	95	58	126	—	111	111	—	111	126	—	107	—	107	107	127	126	107	113	113	—	—	104	—
U.S.A. . . .	107	107	107	107	107	107	107	107	111	111	111	107	—	107	107	107	107	127	126	107	113	113	112	112	107	58
America, North . .	126	126	126	126	111	126	111	111	111	111	111	—	—	—	107	111	127	—	126	—	113	113	112	106	111	58
,, South . .	111	111	111	111	58	111	—	111	111	111	111	—	126	—	—	111	127	—	126	—	113	113	112	106	111	58
,, Central and Caribbean	111	111	111	111	58	111	—	111	111	111	111	—	126	—	—	111	—	—	126	—	113	113	112	106	111	58
Cuba . . .	111	—	45	45	46	46	—	46	45	45	107	—	126	—	—	111	127	—	126	107	113	113	112	46	111	58
San Domingo . .	111	—	111	111	—	111	—	111	111	111	111	—	126	—	—	111	127	—	126	—	113	113	112	106	111	58
Puerto Rico . .	111	—	107	107	—	111	—	107	111	111	107	—	107	—	—	111	—	—	—	107	113	113	112	106	111	58
B.W.I. and British Guiana	111	—	126	100	100	126	—	100	100	100	111	—	126	—	—	100	100	—	—	—	113	113	100	—	100	58
South Africa . .	111	84	84	84	84	84	—	84	111	84	84	—	126	—	—	111	127	—	126	127	84	84	84	84	111	84
Other ,, . .	111	127	127	111	58	—	—	111	111	111	111	—	—	—	—	111	127	—	—	—	113	113	—	106	111	58
India and Pakistan .	111	127	—	127	58	—	—	68	69	69	68	—	—	—	—	111	68	—	—	—	113	113	—	106	69	58
Indonesia . . .	111	—	73	73	73	73	—	73	73	73	73	—	126	—	—	73	127	—	126	—	113	113	73	—	73	73
Philippines . .	111	—	78	78	58	78	—	107	78	78	111	—	107	—	—	111	—	—	—	107	113	113	—	106	78	58
Hawaii . . .	107	—	107	107	58	111	—	107	111	111	107	—	107	—	—	107	—	—	—	107	113	113	112	106	111	58
Far East . . .	111	111	127	111	58	—	—	111	111	111	111	—	—	—	—	111	—	—	—	—	113	113	—	106	111	58
Mauritius . . .	111	—	76	76	—	76	—	76	76	76	111	—	126	—	—	111	—	—	126	—	113	113	—	—	76	—
Fiji . . .	111	—	32	—	—	—	—	31	31	31	32	—	126	—	—	32	—	—	126	—	32	32	—	106	31	—
Australia . . .	111	—	32	32	32	32	—	32	31	31	32	—	—	—	—	32	127	—	126	32	32	32	—	32	31	—

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for sugar consumption are not published, and are reproduced by the courtesy of the Ministry of Food. The exports are analysed in Table 4.

The item "Loss by Difference" in Table 3 is made up of (*a*) changes in water content, (*b*) manufacturing losses, and (*c*) errors in the estimates. At about 1 per cent. it is reasonable.

The distribution among manufacturers is interesting. It is, for instance, surprising to find that sugar used for British Wines and Cider was in 1949 twice as great as that used for Infants' and Invalids' Foods—and eleven times as great in 1938! It is also surprising to find that sugar for "Breakfast Cereals" was zero in 1938 and 4,300 tons in 1949. Another interesting item is Bee Feeding—3,500 tons of sugar in 1949. An estimate of the amount of honey "taken off" by bee keepers in 1949 is about 5,500 tons, containing about 3,800 tons of sugar. Thorold Rogers (25), speaking of the 13th and 14th centuries, said "our forefathers do not appear to have been skilful in the management of bees." We do not appear to have improved very much in the intervening centuries!

3. *World Production*

World sugar production is shown in Table 5 for the last two years and the last pre-war year.

4. *Consumption and Prices*

Per caput consumption figures for the United Kingdom have been shown in Fig. 1. In Table 6 retail prices and *per caput* consumption figures are shown for a number of countries for the years 1938 and 1948/49. A comparison of the *per caput* consumption figures between different countries may be a little misleading, as the figures given represent only the sugar consumed directly or in manufactured articles of which sugar is an ingredient. In addition, however, almost everyone in the world consumes sugar contained in fruit, which is not included in any sugar statistics. In this country it is estimated that we consume about 10 lb. *per caput* per annum in this form, and in countries which consume very small amounts of commercial sugar the consumption of sugar in fruit is probably at least as high as it is in this country, but we have no information.

In Table 6 we have, for a pre-war and a post-war period, the retail price and *per caput* consumption for a number of countries. The correlation coefficient between price and consumption is $-0{\cdot}39$ for 1938 and $-0{\cdot}50$ for 1948/49, both significant at the 1 per cent. level but both low. The fact that there is a tendency for low retail prices to be accompanied by high consumptions does not justify us in drawing any conclusions as there are too many other factors operating. Sugar is an energy food only—just calories and nothing else—so that for instance in countries where rice is the staple diet the consumption of sugar will probably be low whatever the price.

In columns (5) and (6) of Table 6 the outlay on sugar for the two periods is shown, being the amount spent *per caput* per annum on sugar. In 26 cases the figures are available for both periods. The differences are very variable but significant, and average over 100 per cent. increase in outlay in the 10 years without any increase in average consumption. Presumably the increase is due primarily to currency inflation.

5. *Demand*

With regard to the demand for sugar and its response to price changes (in time), the main attempt to study such relations was made by the late Henry Schultz (28), who dealt with certain pre-war periods in the U.S.A.—the nearest approach to a "closed economy" which was available. To his data of consumption and prices he applied six different types of regression equation, with the result that the estimated coefficient of elasticity of demand on price in all six cases lay between $-0{\cdot}3$ and $-0{\cdot}4$, showing that the demand for sugar, like that for most commodities which in any country have become necessities, is inelastic.

III. *Technical*

1. Considering the vast technical literature which has grown up there are surprisingly few modern books dealing with the scientific and technical side of sugar manufacture and refining.

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TABLE 3—*U.K. Sugar and*

SUPPLIES

		1938		1949	
Imports—Raw					
Empire:	Australia	380,600		343,600	
	Mauritius	282,200		261,300	
	B.W.I. and Brit. Guiana	229,500		357,300	
	S. Africa	215,600		43,400	
	Fiji	76,800		4,400	
	E. Africa	14,200		—	
			1,198,900		1,010,000
Non-Empire:	Cuba	614,300		740,000	
	San Domingo	273,400		346,600	
	Java	145,100		—	
	Peru	66,100		12,100	
	European Beet	56,000		—	
	Haiti	18,500		16,300	
	Surinam	500		—	
	Mexico	—		66,600	
	Brazil	—		9,900	
	Others	2,200		—	
			1,176,100		1,191,500
Imports—Refined					
Empire:	E. Africa	800		—	
	British Guiana	300		—	
	Mauritius	100		—	
			1,200		—
Non-Empire:	U.S.A.	30,310		—	
	Czechoslovakia	16,040		—	
	Holland	3,500		—	
	Belgium	1,240		—	
	Germany	310		—	
	Poland	170		—	
	Others	630		—	
			52,200		—
Total Imports			2,428,400		2,201,500
Home Beet Production			311,000		539,000
Stock Adjustments			−20,400		−120,000
Total Sugar			2,719,000		2,620,500
Molasses					
Production from Home Grown Beet		92,500		195,700	
Imports less Stock Adjustment		591,700		409,000	
			684,200		604,700
Total Supplies			3,403,200		3,225,200

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Molasses Supplies and Distribution.

Long Tons. Telquel

	DISTRIBUTION			
	1938		1949	
Direct Consumption				
Domestic	1,100,000		947,500	
Catering establishments	110,000		90,000	
		1,210,000		1,037,500
Manufacturing				
Chocolate and sugar confectionery	296,400		199,700	
Bakers' flour, confectionery and cakes	184,000		111,900	
Jams and preserves	162,400		233,000	
Brewers	76,600		47,300	
Biscuits	60,000		48,800	
Condensed milk and milk crumb	50,600		33,300	
Soft drinks	50,200		35,900	
Syrup and treacle	45,000		85,000	
Bakers' prepared materials	19,700		15,000	
Ice cream	17,300		12,100	
Table jellies	17,200		12,300	
Medicinal	9,400		10,000	
Bottling and canning	9,300		20,600	
Candied peel	8,200		6,300	
Cider	5,800		4,300	
British wines	5,700		3,900	
Bee feeding	5,000		3,500	
Pickles and sauces	4,500		4,500	
Coffee essence	4,300		7,400	
Cake, pudding and sponge mix	3,500		4,500	
Vinegar brewing	2,200		800	
Home brewers and herb beer	1,000		—	
Infants' and invalids' foods	1,000		3,700	
Synthetic honey	800		600	
Breakfast cereals	—		4,300	
Miscellaneous	5,000		4,900	
		1,045,100		913,600
		2,255,100		1,951,100
Total Home Sugar		362,100		566,400
Exports—Refined Sugar (For details see Table 4)				
Molasses				
Distillers	386,000		356,500	
Cattle feed	329,000		228,000	
Yeast	21,000		69,300	
Citric acid	7,800		13,000	
Foundries, etc.	2,400		12,200	
		746,200		679,000
		3,363,400		3,196,500
Total Distribution	(1·2%)	39,800	(0·9%)	28,700
Loss by difference				
		3,403,200		3,225,200
Total Supplies				

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TABLE 4

Exports British Refined Sugar

Long tons

Foreign	1938	1949
Norway	56,641	69
Finland	52,831	3,998
Uruguay	44,746	46,024
Switzerland	42,476	44,728
Eire	32,414	14,046
Estonia	22,162	—
Greece	18,248	784
Turkey	6,876	8,379
Iceland	4,930	—
Iraq	3,118	45,183
Holland	2,422	39
Italy	2,323	1,407
U.S.A.	1,331	202
Germany	1,288	10,068
Morocco	1,028	147
Egypt	887	1,362
Belgium	669	1,757
Denmark	537	2
Palestine	492	245
France	307	24,627
Iran	237	110,648
Saudi Arabia	149	3,709
Syria	63	15,516
Lebanon		5,402
Libya	—	11,528
Portugal	—	10,406
Transjordan	—	3,403
Eritrea	—	2,257
Austria	—	2,120
Ethiopia	—	1,098
Trieste	—	1,093
Goa	—	1,050
Muscat and Oman	—	1,048
French Somaliland	—	851
Thailand	—	98
Other Foreign	6,411	168
Total Foreign	302,586	373,462

British	1938	1949
Br. Malaya	25,369	37,192
Br. West Africa	7,417	22,254
Malta and Gozo	5,538	6,680
Newfoundland	4,872	—
Cyprus	3,213	4,525
Channel Islands	3,066	3,104
B.W.I. and Bahamas	1,723	86
Aden	1,515	4,362
Gibraltar	1,058	1,292
India	195	—
Pakistan		36,076
Canada	101	6
Ceylon	100	8,582
Falkland Islands	21	137
Sudan	—	36,357
Hong Kong	—	8,785
New Zealand	—	8,494
Bahrein, Koweit, etc.	—	6,945
Sarawak	—	4,556
North Borneo	—	1,610
South Africa	—	1,589
Bermuda	—	263
Other British	5,286	14
Total British	59,475	192,909
Total Foreign	302,586	373,462
Total Exports	362,061	566,371

TABLE 5

World Sugar Production

(000) Long tons (Raw basis)

	1938/39	1947/48	1948/49*
Europe	8,604	6,146	8,767
N. America	2,251	2,029	1,679
West Indies	4,569	7,901	7,486
Central and South America	2,682	3,803	3,953
Africa	1,236	1,430	1,493
Australasia	2,850	2,011	2,660
Asia	4,428	2,070	2,114
Total	26,620	25,390	28,152

* Provisional.

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TABLE 6

	Consumption (*Lb.* per caput *per annum*)		*Retail Price* (*Pence per lb.*)		*Outlay* (*Shillings* per caput *per annum*)	
	1938 (1)	1948/49 (2)	1938 (3)	1948/49 (4)	1938 (5)	1948/49 (6)
Albania	11	—	6·3	—	6	—
Arabia	—	—	—	6·7	—	—
Argentine	74	78	2·5	3·1	15	20
Australia	117	130	3·0	3·5	29	38
Austria	61	36	—	8·6	—	26
Belgium	70	61	2·7	7·6	16	39
Brazil	53	67	2·5	5·1	11	28
Bulgaria	11	—	7·3	—	7	—
Canada	103	—	2·7	—	23	—
Chile	60	—	1·7	—	8	—
China	5	—	—	—	—	—
Costa Rica	—	41	—	5·2	—	18
Cuba	84	65	2·2	5·2	15	28
Czechoslovakia	59	53	4·8	8·0	24	35
Denmark	121	86	2·3	2·7	23	23
Egypt	22	22	—	6·1	—	11
Esthonia	58	—	2·9	—	14	—
Finland	67	55	2·9	10·8	16	50
France	55	43	2·9	9·3	13	33
Germany	59	—	7·0	—	34	—
Greece	27	16	3·3	13·1	7	17
Haiti	—	12	—	4·7	—	5
Holland	64	84	5·5	7·5	29	52
Hungary	26	29	8·7	13·6	19	33
India	18	7	2·3	7·5	3	4
Iran	—	19	—	14·8	—	23
Ireland	91	75	3·2	—	24	—
Italy	20	20	8·0	12·5	13	21
Japan, Formosa	24	—	2·6	—	5	—
Java	10	—	1·2	—	1	—
Jugoslavia	13	—	7·0	—	8	—
Latvia	55	—	3·0	—	14	—
Lithuania	27	—	3·8	—	9	—
Madagascar	—	7	—	10·6	—	6
Mauritius	75	—	1·1	—	7	—
Mexico	34	52	1·0	3·3	3	14
New Zealand	116	110	2·8	6·4	27	59
Nicaragua	—	29	—	6·5	—	16
Norway	74	57	3·6	3·4	22	16
Panama	—	30	—	8·8	—	22
Paraguay	—	26	—	5·2	—	11
Peru	30	—	1·5	—	4	—
Poland	29	40	4·3	11·7	10	39
Portugal	20	22	4·4	—	7	—
Rumania	13	—	7·3	—	8	—
South Africa	61	90	2·6	3·7	13	28
Spain	20	16	4·6	16·7	8	22
Sweden	107	95	2·2	5·9	20	47
Switzerland	93	79	2·4	6·6	19	43
Turkey	14	16	4·6	16·5	5	22
U.K.	112	86	2·5	5·0	23	36
Uruguay	—	60	—	5·2	—	26
U.S.A.	96	93	2·8	5·6	22	43
U.S.S.R.	29	16	12·6	33·4	30	45

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The following in the Bibliography are the most important to-day: (1), (2), (3), (4), (5), (11), (14), (19), (23), (26) and (27).

2. In the Bibliography II all journals, proceedings, etc., of a technical nature are marked *t* and are shown by countries for ease of reference, and all the chief technical sugar journals of the world are included. In addition a great deal of information relating to sugar is published in journals not directly connected with sugar. Many of the sugar journals provide useful Abstracts, but the fullest service of abstracts is (103).

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Wholesale Prices in 1949

By the Editor of "The Statist"

Table I

The Statist's *Annual Index Numbers* (*in continuation of Sauerbeck's figures*) (1867–77 = 100)

Year	Average No.	Year	Average No.	Year	Average No.	Year	Average No.	Year	Average No.
1949	274	1928	119	1907	80	1886	69	1865	101
'48	260	'27	122	'06	77	'85	72	'64	105
'47	230	'26	125	'05	72	'84	76	'63	103
'46	186	'25	136	'04	70	'83	82	'62	101
'45	164	'24	139	'03	69	'82	84	'61	98
'44	160	'23	128	'02	69	'81	85	'60	99
'43	155	'22	131	'01	70	'80	88	'59	94
'42	151	'21	155	'00	75	'79	83	'58	91
'41	142	'20	251	1899	68	'78	87	'57	105
'40	128	'19	206	'98	64	'77	94	'56	101
'39	94	'18	192	'97	62	'76	95	'55	101
'38	90	'17	175	'96	61	'75	96	'54	102
'37	102	'16	136	'95	62	'74	102	'53	95
'36	88	'15	108	'94	63	'73	111	'52	78
'35	83	'14	85	'93	68	'72	109	'51	75
'34	81	'13	85	'92	68	'71	100	'50	77
'33	78	'12	85	'91	72	'70	96	'49	74
'32	79	'11	80	'90	72	'69	98	'48	78
'31	82	'10	78	'89	72	'68	99	'47	95
'30	96	'09	74	'88	70	'67	100	'18	159*
'29	114	'08	73	'87	68	'66	102	'10	171*

* Jevons's numbers adjusted.

Table II

The Statist's *Annual Index Numbers—ten-year averages* (1867–77)

1848–1857 = 89	1899–1908 = 72	1913–1922 = 153	1927–1936 = 95
'58– '67 = 99	1900– '09 = 73	'14– '23 = 157	'28– '37 = 93
'68– '77 = 100	'01– '10 = 73	'15– '24 = 162	'29– '38 = 90
'78– '87 = 79	'02– '11 = 74	'16– '25 = 165	'30– '39 = 88
'88– '97 = 67	'03– '12 = 76	'17– '26 = 164	'31– '40 = 91
'90– '99 = 66	'04– '13 = 77	'18– '27 = 159	'32– '41 = 97
'91–1900 = 66	'05– '14 = 79	'19– '28 = 152	'33– '42 = 104
'92– '01 = 66	'06– '15 = 82	'20– '29 = 142	'34– '43 = 111
'93– '02 = 66	'07– '16 = 88	'21– '30 = 127	'35– '44 = 119
'94– '03 = 66	'08– '17 = 98	'22– '31 = 120	'36– '45 = 127
'95– '04 = 67	'09– '18 = 110	'23– '32 = 115	'37– '46 = 137
'96– '05 = 68	'10– '19 = 123	'24– '33 = 110	'38– '47 = 150
'97– '06 = 70	'11– '20 = 146	'25– '34 = 104	'39– '48 = 167
'98– '07 = 71	'12– '21 = 148	'26– '35 = 99	'40– '49 = 185

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*Monthly Fluctuations of the Index Numbers * of 45 Commodities, 1867–77 = 100*

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1898 . .	62·8	63·4	63·0	65·5	66·4	64·7	64·3	64·0	63·9	63·6	63·9	63·8	64
1901 . .	72·2	71·7	71·0	70·6	70·5	69·8	69·5	69·8	69·6	69·6	69·0	68·4	70
1904 . .	70·4	70·8	70·8	70·5	69·9	69·4	69·9	70·4	70·7	71·0	71·2	70·9	70
'05 . .	71·2	71·4	71·8	72·0	71·7	72·0	72·5	72·3	72·4	73·2	74·2	74·9	72
'06 . .	75·2	75·0	75·7	76·5	77·0	76·9	76·4	76·7	77·5	78·5	78·6	79·7	77
'07 . .	80·0	80·7	80·0	80·7	82·4	82·0	81·1	79·4	79·1	78·8	76·7	76·2	80
'08 . .	76·0	74·5	74·1	73·8	73·6	72·9	73·1	72·2	72·5	72·2	72·2	72·3	73
1909 . .	72·0	71·9	72·4	74·3	75·4	75·1	75·2	74·9	74·7	75·2	75·5	76·3	74
'10 . .	77·1	78·1	79·1	78·5	78·2	76·9	78·1	78·2	77·6	77·2	77·8	77·9	78
'11 . .	78·5	78·6	78·9	80·0	80·3	80·0	78·9	79·5	80·3	80·7	80·6	80·9	80
'12 . .	81·8	82·9	84·4	85·0	85·3	85·5	86·5	85·9	86·7	85·8	85·3	86·4	85
'13 . .	86·4	86·1	86·7	86·2	85·7	84·1	84·2	85·0	85·7	84·5	83·3	83·8	85
1914 . .	83·5	83·8	82·8	82·3	82·3	81·2	82·4	87·9	89·3	89·8	88·8	91·6	85
'15 . .	96·4	100·9	103·7	105·9	107·2	106·4	106·4	107·0	107·8	110·0	113·1	118·4	108
'16 . .	123·6	127·0	130·4	134·2	135·4	131·0	130·5	134·5	134·4	141·5	150·8	154·3	136
'17 . .	159·3	164·0	169·0	173·0	175·0	180·4	176·9	175·7	176·4	180·6	182·9	185·1	175
'18 . .	186·2	187·3	188·0	189·8	191·1	192·3	192·9	195·9	197·1	197·8	195·3	196·0	192
1919 . .	192·1	187·5	184·7	184·6	194·6	199·4	206·4	212·7	214·8	224·3	231·0	235·2	206
'20 . .	245·3	260·4	261·8	266·1	260·0	255·7	254·6	253·5	248·7	239·9	223·8	207·2	251
'21 . .	197·2	183·0	177·2	169·8	162·2	155·8	158·2	154·3	149·4	138·4	136·7	133·6	155
'22 . .	132·5	132·2	133·3	134·8	135·5	135·6	134·0	129·6	127·9	130·1	130·6	129·1	131
'23 . .	130·2	131·9	132·7	134·0	132·2	127·9	124·8	125·0	127·8	127·7	132·4	133·2	128
1924 . .	137·2	138·8	137·0	136·8	136·4	136·3	138·4	138·0	141·3	146·1	145·5	147·7	139
'25 . .	144·8	143·1	140·1	137·5	135·7	131·2	134·3	134·3	132·7	130·2	132·9	130·4	136
'26 . .	129·3	127·9	126·1	125·5	125·7	124·9	126·0	127·0	128·0	131·0	130·8	123·9	125
'27 . .	123·1	124·1	123·6	123·3	123·8	123·1	122·0	122·8	121·5	120·6	121·5	121·4	122
'28 . .	120·9	121·1	123·6	125·6	126·2	122·6	120·3	118·0	116·8	116·8	117·9	117·9	119
1929 . .	117·0	120·1	120·5	116·5	113·0	113·1	115·2	113·9	112·6	111·1	108·3	108·8	114
'30 . .	106·6	104·8	103·0	101·5	98·8	95·8	94·4	92·2	90·8	90·4	88·6	86·9	96
'31 . .	85·7	85·5	85·5	84·4	82·2	82·6	80·2	79·1	80·7	82·3	83·0	85·4	82
'32 . .	84·7	86·7	84·1	82·5	80·2	77·0	78·9	80·7	80·4	77·8	77·9	77·7	79
'33 . .	77·8	77·0	77·0	78·5	80·9	81·3	81·7	81·2	80·7	80·5	79·3	80·0	78
1934 . .	82·5	82·5	82·2	81·0	81·1	80·7	82·4	83·4	82·1	81·1	81·0	82·8	81
'35 . .	83·6	83·4	82·9	84·1	85·2	83·7	84·3	84·1	85·1	85·8	86·3	86·7	83
'36 . .	87·1	87·1	86·7	86·2	85·6	84·8	87·1	89·0	90·4	91·7	94·5	98·9	88
'37 . .	99·6	102·1	107·3	104·7	106·2	104·7	105·9	104·4	103·3	100·8	96·7	97·3	102
'38 . .	96·5	96·4	94·2	93·5	91·4	91·4	91·1	88·6	88·6	88·8	87·4	89·1	90
1939 . .	88·7	88·6	89·0	90·5	90·6	90·6	88·7	90·4	99·7	105·8	112·2	120·1	94
'40 . .	124·1	124·5	123·4	126·0	128·0	130·0	129·5	131·5	131·6	131·8	132·7	134·5	128
'41 . .	134·9	136·3	138·0	141·1	143·5	144·4	145·3	145·1	145·5	143·7	145·5	146·5	142
'42 . .	148·6	153·4	153·5	154·5	156·6	154·4	150·0	149·4	149·7	150·4	151·3	152·2	151
'43 . .	153·3	153·2	154·0	154·9	155·6	155·4	156·0	154·4	154·6	153·7	153·9	153·9	155
1944 . .	154·9	155·1	155·7	157·9	159·5	160·0	161·9	161·5	160·1	159·6	160·3	160·7	160
'45 . .	161·4	161·5	162·1	162·4	164·0	166·7	165·2	163·3	162·7	162·7	162·7	163·2	164
'46 . .	165·6	166·2	166·6	168·4	169·3	169·7	174·4	175·7	180·5	196·2	198·1	200·5	186
'47 . .	206·7	209·6	212·1	215·9	216·5	218·1	223·4	225·9	228·9	236·0	240·8	246·5	230
'48 . .	250·5	253·4	256·0	256·4	260·0	263·9	260·4	260·1	258·1	261·5	263·8	266·0	260
'49 . .	267·6	266·8	265·4	272·0	269·2	267·2	263·3	262·5	285·7	291·5	293·7	297·4	274
'50 . .	300·2	301·0	301·7	305·2	308·3	310·3							

* The average of the twelve monthly figures of each year does not necessarily coincide with the annual figures, as the latter are calculated mostly from the average of 52 weekly quotations, while the former are based on end-of-the-month prices.

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Quarterly Movements of Prices *

Summary of Index Numbers, 1867–77 = 100

Years	Quarters	Vegetable Food (Corn, etc.)	Animal Food (Meat, etc.)	Sugar, Coffee, and Tea	Total Food	Minerals	Textiles	Sundry Materials	Total Materials	Grand Total	Silver †
'38	I	92·3	116·4	43·1	90·8	134·8	77·8	92·4	99·3	**95·7**	18·5
	II	89·2	114·1	42·2	88·5	132·0	73·5	86·5	94·8	**92·1**	17·4
	III	78·0	107·4	42·9	81·4	135·9	73·9	85·0	95·3	**89·4**	17·3
	IV	68·8	105·8	43·3	77·1	140·6	74·3	85·1	96·7	**88·4**	17·4
'39	I	68·0	110·9	43·5	78·7	134·2	79·6	84·0	96·2	**88·8**	17·7
	II	66·7	112·9	46·9	79·6	134·4	85·7	85·3	98·7	**90·6**	17·3
	III	65·2	117·0	48·1	80·7	135·8	91·1	88·0	101·8	**92·9**	15·7
	IV	93·2	130·3	57·4	99·3	146·7	123·5	106·4	122·5	**112·7**	17·8
'40	I	104·2	141·2	57·4	108·0	160·1	141·2	116·1	135·6	**124·0**	16·3
	II	108·0	140·5	56·7	109·2	165·2	148·4	122·2	141·8	**128·0**	16·7
	III	117·3	140·5	58·6	113·5	171·1	148·6	122·2	143·4	**130·9**	17·6
	IV	127·5	140·5	58·8	117·8	173·5	151·9	119·8	144·1	**133·0**	17·9
'41	I	129·8	141·3	61·9	119·8	179·0	154·8	124·7	148·6	**136·4**	18·0
	II	137·9	142·8	65·3	124·4	181·2	161·6	137·2	156·6	**143·0**	18·0
	III	145·0	142·8	65·4	127·4	181·0	165·6	138·5	158·3	**145·3**	18·0
	IV	151·0	142·8	68·9	130·7	181·6	163·1	134·2	155·8	**145·2**	18·1
'42	I	179·6	144·3	69·3	143·4	181·6	161·1	140·6	157·9	**151·8**	18·1
	II	188·6	147·3	69·5	148·3	182·2	160·4	146·1	160·2	**155·2**	18·1
	III	158·4	147·3	71·4	136·0	185·8	158·3	144·1	159·7	**149·7**	18·1
	IV	156·6	151·1	71·4	136·7	186·8	164·9	145·0	162·0	**151·3**	18·1
'43	I	159·1	155·7	72·8	139·7	188·0	163·9	148·4	163·8	**153·5**	18·1
	II	159·9	155·7	73·1	140·1	188·3	165·1	153·5	166·4	**155·3**	18·1
	III	156·1	155·7	74·1	138·7	188·2	163·4	156·0	166·9	**155·0**	18·1
	IV	150·1	155·7	74·2	136·2	187·8	160·8	157·4	166·6	**153·8**	18·1
'44	I	151·6	155·7	73·7	136·7	191·4	161·1	159·6	168·6	**155·2**	18·1
	II	151·8	155·7	74·5	137·0	193·9	180·0	160·2	175·3	**159·1**	18·1
	III	152·2	155·7	75·8	137·4	199·3	183·7	161·4	178·5	**161·2**	18·1
	IV	151·4	155·7	73·7	136·7	203·9	184·6	155·4	177·5	**160·2**	18·1
'45	I	154·8	155·7	73·7	138·0	204·8	186·0	157·3	178·9	**161·7**	19·6
	II	160·5	155·7	74·6	140·6	209·4	189·8	158·3	181·7	**164·4**	19·5
	III	157·7	155·7	73·8	139·2	212·5	189·7	156·2	181·6	**163·7**	20·2
	IV	154·7	155·7	74·4	138·2	212·1	190·0	154·3	180·8	**162·9**	31·1
'46	I	155·7	155·7	78·6	139·4	225·5	191·5	155·9	185·5	**166·1**	31·1
	II	157·2	154·3	81·0	140·1	230·9	195·1	160·9	190·3	**169·1**	31·1
	III	156·0	154·3	84·5	140·3	248·5	211·6	168·9	203·4	**176·9**	38·2
	IV	153·0	154·7	86·6	139·7	260·9	272·3	205·9	240·9	**198·3**	41·6
'47	I	156·0	154·7	91·4	141·9	282·9	286·7	223·4	258·9	**209·5**	36·7
	II	162·9	150·3	98·0	144·7	288·9	284·5	246·5	269·6	**216·8**	32·8
	III	187·1	146·7	102·2	154·3	295·4	298·0	253·6	278·5	**222·2**	30·4
	IV	200·8	144·0	103·0	159·3	322·7	330·0	267·8	300·9	**241·1**	33·4
'48	I	208·5	152·2	103·3	165·7	355·6	336·2	279·4	317·4	**253·3**	33·7
	II	215·5	155·3	105·0	170·1	362·5	356·8	280·1	325·9	**260·1**	33·7
	III	216·3	155·3	106·7	170·8	367·3	350·2	278·2	324·4	**259·5**	33·9
	IV	220·7	155·3	112·5	173·8	384·9	349·4	279·7	329·5	**263·8**	33·6
'49	I	224·9	155·3	117·0	176·6	392·0	353·0	279·3	332·3	**266·6**	32·2
	II	245·8	196·7	117·7	200·8	370·0	338·5	274·0	319·7	**269·4**	32·6
	III	244·7	197·4	133·2	203·8	378·0	337·5	268·6	319·2	**270·5**	33·0
	IV	250·8	197·4	198·3	220·1	389·8	407·3	279·5	348·5	**290·9**	33·3

* The averages of the four quarterly figures to each year do not necessarily coincide with the annual averages, as the latter are based as far as possible on average weekly prices. See also the *Journal*, 1893, p. 221; 1895, p. 144; 1901, p. 90; and 1909, p. 70.

† Silver, parity of 1 gold to 15½ silver = 100.

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Construction of the Tabular Statements

The following table illustrates the method of construction of the index numbers. The index numbers here given are based on the average prices for the eleven years 1867–77. Take, for instance, the *Gazette* price of English wheat:

		s.	d.				
Average,	1867–77	54	6	= 100, average point.			
,,	1914	35	0	= 64, or 36 per cent.	*below*	the average point.	
,,	1930	80	7	= 148, ,, 48	,,	*above*	,, ,,
,,	1936	53	3	= 98, ,, 2	,,	*below*	,, ,,

The individual index numbers, therefore, represent simple percentages of the average point. The articles are grouped in six categories:

	Index Nos.	1867–77 Total Numbers	Example for 1949	
			Total Numbers	Average
1. Vegetable food, corn, etc. (wheat flour, barley, oats, maize, potatoes, and rice)	8	800	1,921	240
2. Animal food (beef, mutton, pork, bacon, and butter)	7	700	1,292	185
3. Sugar, coffee, and tea	4	400	605	151
1–3. *Food*	19	1,900	3,818	201
4. Minerals (iron, copper, tin, lead, and coal)	7	700	2,673	382
5. Textiles (cotton, flax, hemp, jute, wool, and silk)	8	800	2,849	356
6. Sundry materials (hides, leather, tallow, oils, soda, nitrate, indigo, and timber)	11	1,100	3,002	273
4–6. *Materials*	26	2,600	8,524	328
General Average	45	4,500	12,342	274

The general average is drawn from all forty-five descriptions which are treated as of equal value, and is the simple arithmetic mean as shown above.

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Summary of Index Numbers. Groups of Articles, 1867–77 = 100

	Vegetable Food (Corn, etc.)	Animal Food (Meat, etc.)	Sugar, Coffee, and Tea	Total Food	Minerals	Textiles	Sundry Materials	Total Materials	Grand Total	Silver*	Wheat Harvest †	Average Price of Consols ‡	Average Bank of England Rate ‡
												£	%
1873 .	106	109	106	107	141	103	106	114	**111**	97·4	80	92½	4·750
1896 .	53	73	59	62	63	54	63	60	**61**	50·5	112	110¾	2·483
1911 .	70	90	61	75	93	76	81	83	**80**	40·4	110	79 5/16	3·467
1919 .	179	213	147	185	220	228	219	222	**206**	85·3	98	54 1/12	5·166
1922 .	107	184	82	130	142	134	122	131	**131**	51·6	105	56 5/32	3·692
'23 .	98	162	101	122	155	140	115	133	**128**	49·4	105	57 3/64	3·496
'24 .	119	158	105	130	158	170	119	145	**139**	50·7	107	56 3/64	4·0
'25 .	118	162	89	128	154	165	117	142	**136**	52·5	114	56⅜	4·575
'26 .	108	150	88	119	154	133	112	130	**125**	47·1	99	54 29/30	5·0
1927 .	108	138	83	114	141	131	116	127	**122**	42·8	109	54 39/40	4·650
'28 .	107	142	78	114	123	136	114	123	**119**	44·0	109	55 1/16	4·5
'29 .	99	146	72	110	126	122	108	117	**114**	40·2	114	54 5/16	5·508
'30 .	77	142	54	96	112	84	94	96	**96**	29·0	99	56	3·4
'31 .	68	119	50	83	100	63	81	80	**82**	20·4	99	55 3/16	3·975
1932 .	72	105	50	79	99	64	78	80	**79**	19·5	105	66 25/32	3·017
'33 .	60	106	47	74	107	67	76	82	**78**	18·7	114	73 29/32	2·0
'34 .	63	108	50	77	109	72	76	84	**81**	20·0	120	80 31/32	2·0
'35 .	66	107	42	76	112	80	79	88	**83**	26·4	112	86½	2·0
'36 .	76	109	41	81	118	83	84	93	**88**	18·5	100	85 11/64	2·0
1937 .	93	117	49	93	142	93	98	109	**102**	18·4	99	76 9/32	2·0
'38 .	81	111	43	84	136	75	83	95	**90**	17·6	122	74 5/32	2·0
'39 .	74	115	47	83	137	93	88	102	**94**	17·1	112	66 33/64	2·5
'40 .	112	141	58	111	167	149	117	140	**128**	17·1	108	72 9/16	2·0
'41 .	140	142	65	125	181	162	131	154	**142**	18·0	109	79 13/16	2·0
1942 .	170	148	66	140	184	163	142	160	**151**	18·1	123	82 5/16	2·0
'43 .	156	156	72	138	187	166	156	167	**155**	18·1	123	80¾	2·0
'44 .	152	156	73	137	197	182	161	178	**160**	18·1	121	80 5/32	2·0
'45 .	155	156	78	139	209	189	159	182	**164**	23·1	—	87 13/16	2·0
'46 .	155	154	88	140	239	231	198	219	**186**	36·7	—	95 13/32	2·0
'47 .	191	149	100	156	304	295	263	284	**230**	33·3	—	89½	2·0
'48 .	217	155	107	171	368	348	279	324	**260**	34·1	—	78 27/32	2·0
'49 .	240	185	151	201	382	356	273	328	**274**	32·8	—	73 13/32	2·0
Average													
1904–13	68	91	53	73	95	74	76	81	**77**	44·1	106	82 5/32	3·733
1890–99	61	80	63	68	71	56	66	64	**66**	55·8	103	103 9/16	2·958
'78–87	79	95	76	84	73	71	81	76	**79**	82·1	97	99 9/16	3·264
1818–27	109	90	151	111	128	105	106	112	**111**	98·0	—	—	3·692

* Silver (see note on p. 386), parity of 1 gold to 15½ silver = 100.

† Wheat harvest in U.K. to 1895: 29 bushels = 100; from 1896: 30 bushels = 100.

‡ Average price of Consols and the average Bank of England rate of discount are actual figures, not index-numbers; Consols 3% to 1888, 2¾% from 1889, 2½% from April, 1903.

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THE STATIST'S *Index Numbers—monthly average by groups*, 1867–77 = 100

	Vegetable Food	Animal Food	Sugar, Tea, and Coffee	Food-stuffs	Minerals	Textiles	Sundry Materials	Total Materials	All Commodities
1947									
Jan.	156·0	154·7	91·1	141·9	277·5	287·6	215·1	254·2	206·7
Feb.	156·0	154·7	92·0	142·0	280·1	287·6	224·8	258·9	209·6
Mar.	156·1	154·7	91·2	141·9	291·0	284·9	230·4	263·5	212·1
April	157·3	154·7	93·7	143·0	289·7	284·1	245·5	269·2	215·9
May	158·1	148·1	101·0	142·4	288·4	285·1	249·0	270·7	216·5
June	173·5	148·1	99·4	148·6	288·7	284·2	245·1	268·9	218·1
July	182·0	148·1	100·9	152·3	293·1	292·9	251·0	275·2	223·4
Aug.	188·5	148·1	102·4	155·5	293·3	297·1	253·0	277·4	225·9
Sept.	190·9	144·0	103·2	155·1	299·9	303·9	256·8	282·9	228·9
Oct.	196·5	144·0	102·9	157·5	311·2	320·7	262·6	293·6	236·0
Nov.	201·8	144·0	104·1	160·0	315·9	328·2	269·2	299·9	240·8
Dec.	204·2	144·0	102·1	160·5	340·9	333·2	271·6	309·2	246·5
1948									
Jan.	207·5	146·1	100·0	162·3	350·8	334·5	278·2	315·0	250·5
Feb.	207·7	155·3	101·5	166·0	356·4	335·3	279·4	317·3	253·4
Mar.	210·4	155·3	108·5	168·7	359·5	338·7	280·7	319·8	256·0
April	210·0	155·3	105·7	168·0	360·2	342·6	280·6	321·1	256·4
May	211·4	155·3	103·4	168·0	359·4	364·4	279·6	327·2	260·0
June	225·1	155·3	105·8	174·3	367·8	363·4	280·2	329·4	263·9
July	214·6	155·3	106·9	170·1	367·6	355·1	279·1	326·4	260·4
Aug.	217·2	155·3	107·8	171·4	366·9	350·6	279·7	325·0	260·1
Sept.	217·1	155·3	105·5	170·9	367·3	345·0	275·9	321·8	258·1
Oct.	217·7	155·3	110·6	172·2	385·1	342·9	278·1	326·8	261·5
Nov.	222·5	155·3	112·2	174·5	384·9	348·4	279·3	329·0	263·8
Dec.	221·8	155.3	114.7	174.8	384.7	357.0	281.8	332.6	266·0
1949									
Jan.	223·6	155·3	117·2	176·1	392·4	358·1	280·4	334·4	267·6
Feb.	224·7	155·3	119·0	177·0	392·3	353·8	278·7	332·4	266·8
Mar.	226·3	155·3	114·7	176·7	391·4	347·1	278·9	330·2	265·4
April	242·7	195·4	115·0	198·4	380·0	344·1	278·1	325·9	272·0
May	243·7	197·4	117·1	200·0	370·9	338·3	273·6	319·7	269·2
June	251·0	197·4	121·0	203·9	359·0	333·1	270·3	313·5	267·2
July	246·5	197·4	123·1	202·4	358·7	319·1	267·3	307·8	263·3
Aug.	238·7	197·4	123·8	199·3	360·7	321·1	266·6	308·7	262·5
Sept.	248·9	197·4	152·8	209·7	414·7	372·3	271·9	341·2	285·7
Oct.	248·9	197·4	173·5	214·0	403·2	397·3	277·6	348·2	291·5
Nov.	251·7	197·4	205·0	221·9	382·9	407·9	278·7	346·5	293·7
Dec.	251·9	197·4	216·5	224·3	383·4	416·7	282·3	350·9	297·4
1950									
Jan.	253·1	197·4	222·4	226·1	382·8	425·5	284·4	354·3	300·2
Feb.	252·8	197·4	214·9	224·4	382·1	426·1	290·8	357·0	301·0
Mar.	253·4	197·4	204·5	222·5	371·2	437·3	295·5	359·5	301·7
April	266·9	200·6	202·3	228·9	375·0	437·8	296·2	361·0	305·2
May	269·7	204·2	199·3	230·8	382·5	443·5	296·6	364·9	308·3
June	280·5	204·2	213·6	238·3	379·7	445·0	292·4	362·8	310·3

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Index of Silver Prices

The base of the index numbers given below is 60·84*d.* per standard oz. = 100, this being a parity of 1 fine oz. of gold to 15½ standard ozs. of silver.*

	Price per oz. standard	Index number		Price per oz. standard	Index number
	d.			*d.*	
Average 1873	59¼	=97·4	*Lowest* Nov., 1902	21 1/16	=35·6
,, '90–99	34	=55·8	End Dec., 1906	32 5/16	=53·1
,, 1917–26	40½	=66·6	,, Dec., '08	23 3/16	=38·1
,, 1893	35⅝	=58·6	,, Dec., '13	26 9/16	=43·7
,, 1914	25 5/16	=41·6	,, Dec., '14	22 11/16	=37·3
,, '15	23 11/16	=38·9	,, Dec., '15	26¼	=43·1
,, '16	31 5/16	=50·4	,, Dec., '16	36½	=58·7
,, '17	40⅞	=65·8	,, Dec., '17	43½	=70·0
,, '18	47½	=76·4	,, Dec., '18	48 7/16	=77·9
,, '19	57	=85·3	,, Dec., '19	77½	=98·3
,, '20	61 9/16	=76·1	,, Dec., '20	40⅞	=49·2
,, '21	36⅞	=48·1	,, Dec., '21	34⅝	=49·3
,, '22	34 7/16	=51·6	,, Dec., '22	31 9/16	=49·6
,, '23	31 5/16	=49·4	,, Dec., '23	33 7/16	=49·0
,, '24	34	=50·7	,, Dec., '24	31 13/16	=50·4
,, '25	32⅛	=52·5	,, Dec., '25	31 13/16	=52·1
,, '26	28 1/16	=47·1	,, Dec., '26	25	=41·1
,, '27	26 1/32	=42·8	,, Dec., '27	26½	=43·6
,, '28	26¾	=44·0	,, Dec., '28	26⅜	=43·3
,, '29	24 7/16	=40·2	,, Dec., '29	21 7/16	=35·2
,, '30	17 11/16	=29·0	,, Dec., '30	14 7/16	=23·7
,, '31	14⅜	=20·4	,, Dec., '31	20 7/16	=21·6
,, '32	17⅛	=19·5	,, Dec., '32	16½	=17·2
,, '33	18⅛	=18·7	,, Dec., '33	19 1/16	=19·5
,, '34	21 7/32	=20·0	,, Dec., '34	24⅜	=22·6
,, '35	29	=26·4	,, Dec., '35	22½	=20·6
,, '36	20 1/16	=18·5	,, Dec., '36	21 5/16	=19·4
,, '37	20 1/16	=18·4	,, Dec., '37	19 1/16	=17·7
,, '38	19 3/32	=17·6	,, Dec., '38	20 1/16	=17·3
,, '39	20 3/32	=17·1	,, Dec., '39	22½	=17·3
,, '40	22 19/64	=17·1	,, Dec., '40	23 5/16	=17·9
,, '41	23 7/16	=18·0	,, Dec., '41	23½	=18·1
,, '42	23½	=18·1	,, Dec., '42	23½	=18·1
,, '43	23½	=18·1	,, Dec., '43	23½	=18·1
,, '44	23½	=18·1	,, Dec., '44	23½	=18·1
,, '45	30½	=23·1	,, Dec., '45	44	=31·1
,, '46	48⅝	=36·7	,, Dec., '46	55½	=41·6
,, '47	44 7/16	=33·3	,, Dec., '47	45	=33·8
,, '48	45	=34·1	,, Dec., '48	2½	=31·9
,, '49	49⅕	=32·8	,, Dec., '49	64	=33·3

* All the index numbers in the table from 1916 to 1925 inclusive and from 1931 to date are calculated on the basis of the gold prices of silver instead of the sterling prices, though the latter are the price quotations given in the table. In arriving at the index numbers for these dates the prices of gold are taken as follows: For 1916, 1917 and 1918 the price is taken as 86*s.* 9½*d.* per fine oz., derived from the "pegged" New York rate of $4·76½ to the £. For 1919 the average price of gold is taken as 93*s.* 4¼*d.*, this being the parity price with the U.S. dollar, the average New York exchange in that year being $4·429. For the other dates the index numbers are based on the quotations in the London market for exportable gold.

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World's Production of Silver (*in millions of ounces*)

	United States	Mexico	Canada	Australia	Other Countries	Total
1906	56·5	55·2	8·5	14·2	30·6	165·0
'07	56·5	61·0	12·8	19·0	34·8	184·2
'08	52·4	73·6	22·1	17·2	37·8	203·1
'09	54·7	73·9	27·5	16·3	39·7	212·1
'10	57·1	71·4	32·9	21·5	38·8	221·7
'11	60·4	79·0	32·7	16·6	37·5	226·2
'12	63·8	74·6	31·6	18·1	36·2	224·3
'13	66·8	70·7	31·5	3·5	51·4	223·9
'14	72·4	27·5	28·4	3·6	36·5	168·4
'15	74·9	39·5	28·4	4·1	37·3	184·2
'16	74·4	38·2	25·4	4·2	26·6	168·8
'17	71·7	35·0	22·2	10·0	35·3	174·2
'18	67·8	62·5	21·2	10·0	35·9	197·4
'19	56·7	62·7	15·7	7·4	32·0	174·5
'20	55·5	66·8	12·6	7·5	33·0	175·4
'21	53·1	64·5	13·1	4·9	35·7	171·3
'22	56·2	81·1	18·6	11·3	46·3	213·5
'23	73·3	90·9	17·8	13·3	50·7	246·0
'24	65·3	91·5	19·7	10·8	52·2	239·5
'25	66·1	92·9	20·2	11·1	54·8	245·1
'26	62·7	98·3	22·4	11·2	59·0	253·6
'27	60·4	104·6	22·7	9·0	57·3	254·0
'28	58·4	108·5	21·9	9·0	59·5	257·3
'29	61·2	108·7	23·1	9·0	59·7	261·7
'30	51·0	105·0	26·0	8·9	57·1	248·0
'31	31·0	86·0	21·0	7·6	50·4	196·0
'32	24·0	69·0	18·0	6·5	47·5	165·0
'33	22·8	68·1	15·2	11·0	52·0	169·1
'34	32·5	74·1	16·4	10·8	56·6	190·4
'35	45·6	75·6	16·6	11·4	71·5	220·7
'36	63·4	77·5	18·3	12·7	81·8	253·7
'37	71·3	84·7	22·7	14·3	81·5	274·5
'38	61·7	81·0	23·8	101·3		267·8
'39	63·9	75·9	24·5	101·6		265·9
'40	68·3	82·6	25·3	96·3		272·5
'41	71·1	78·4	23·4	81·7		254·6
'42	55·9	84·9	21·2	71·8†		—
'43	40·9	71·2	18·0	59·3†		—
'44	35·7	63·0	14·2	57·7†		—
'45	29·0	61·1	13·6	46·4†		—
'46	21·1	48·3	13·1	47·1†		—
'47	36·1	49·2	12·5	44·6†		—
'48	36·1	45·8	16·1	41·0†		—
'49*	34·0	50·0	16·9	—		—

* Provisional. (Estimate by Messrs. Samuel Montagu & Co.) † Incomplete

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(000's omitted)

Year	Value of output £	Year	Value of output £	Year	Value of output £
1851	17,200	1884	20,830	1917	87,236
'52	26,550	'85	21,250	'18	78,605
'53	31,090	'86	21,430	'19	73,078
'54	25,490	'87	21,735	'20	68,522
'55	27,015	'88	22,644	'21	67,848
'56	29,520	'89	25,375	'22	66,723
'57	26,655	'90	24,421	'23	77,888
'58	24,930	'91	26,846	'24	81,807
'59	24,970	'92	30,134	'25	82,267
'60	23,850	'93	32,363	'26	82,211
'61	22,760	'94	37,229	'27	82,582
'62	21,550	'95	40,843	'28	82,400
'63	21,390	'96	41,559	'29	84,500
'64	22,600	'97	48,509	'30	88,500
'65	24,040	'98	58,949	'31	95,100
'66	24,220	'99	63,027	'32	103,400
'67	22,805	1900	52,312	'33	107,700
'68	21,945	'01	53,630	'34	116,000
'69	21,245	'02	60,975	'35	125,700
'70	21,370	'03	67,337	'36	140,900
'71	25,400	'04	71,380	'37	148,700
'72	24,200	'05	78,143	'38	159,000
'73	23,600	'06	82,707	'39	165,900
'74	22,950	'07	84,857	'40	174,000*
'75	22,700	'08	90,995	'41	167,200*
'76	22,540	'09	93,302	'42	146,300*
'77	23,830	'10	93,544	'43	113,200*
'78	22,020	'11	94,930	'44	101,800*
'79	21,400	'12	95,783	'45	97,900*
'80	22,130	'13	97,481	'46	99,200*
'81	21,150	'14	92,709	'47	100,000*
'82	20,500	'15	97,114	'48	102,900*
'83	20,640	'16	92,597	'49	105,800*

Gold.—The table shows the world's annual gold production since 1851. Before 1911 the estimates are those of the Bureau of the U.S. Mint and other authorities. The estimates since 1926 are those of the Union Corporation, Limited. The value is taken throughout at £4·25 per fine oz.

* Estimated or provisional figure.

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*Average Prices of Commodities**

No. of Article	0	1	2	3	4	5	6	7	8	1–8	9	10
		Wheat		Flour	Barley	Oats	Maize §	Potatoes*	Rice	Vegetable Food	Beef ‡	
Year	Silver †	English *Gazette*	American	Town Made white (now "G.R.")	English *Gazette*	English *Gazette*	American Mixed	Good English	Rangoon Cargoes to Arrive	Total	Prime	Middling
	d. per oz.	*s.* and *d.* per qr.	*s.* and *d.* per qr.	*s.* per sack (280 lbs.)	*s.* and *d.* per qr.	*s.* and *d.* per qr.	*s.* per qr.	*s.* per ton	*s.* and *d.* per cwt.		*d.* per 8 lbs.	*d.* per 8 lbs.
1922 ..	34 7/16	47·10	52·11	45 3/4	40·1	29·1	31 1/4	130	14·10	—	88 5/8	82
'28 ..	26 3/4	44·8	50·10	40 1/8	39·0	29·0	38 15/32	133	15·0	—	74	66 1/2
'29 ..	24 7/16	42·2	51·3	38 1/2	35·5	24·7	36 1/4	111	14·3	—	71	66
'30 ..	17 11/16	34·3	36·10	33 1/2	28·3	17·2	23	93	13·0	—	73	68
'31 ..	14 3/8	24·0	25·1	22 7/8	28·0	17·8	15 9/16	146	9·8	—	67	61
'32 ..	17 7/32	25·0	27·5	24 7/32	27·1	19·3	18 3/16	152	9·8	—	65	59
'33 ..	18 1/8	22·10	25·7	23 9/32	28·7	15·10	17 1/16	86	7·9	—	61	52
'34 ..	21 7/32	20·2	28·0	23 1/8	30·11	17·5	19 13/32	97	7·8	—	58	52
'35 ..	29	22·2	31·1	25 3/4	28·7	18·9	17 1/4	107	8·10	—	54	49
'36 ..	20 1/16	30·9	35·1	31 17/32	29·5	17·8	19 1/2	146	9·0	—	54	50
'37 ..	20 1/16	40·0	49·7	40 1/2	39·0	23·11	26 9/16	136	10·5	—	61	57
'38 ..	19 17/32	28·11	39·3	30 21/32	36·4	21·2	28 1/16	111	10·7	—	62	58
'39 ..	20 13/32	21·5	30·1	22 9/32	31·7	19·3	26 1/2	117	11·1	—	61	58
'40 ..	22 19/64	42·10	33·6	24 5/16	64·10	37·2	39 1/16	143	15·5	—	72	68
'41 ..	23 7/16	62·10	32·2	27 1/2	85·8	40·10	43 ‖	164	23·8	—	72	68
'42 ..	23 1/2	68·6	36·9	35	165·5	42·0	43 ‖	134	26·0	—	76	68
'43 ..	23 1/2	69·8	45·5	38 1/4	112·5	43·8	43 ‖	111	27·2	—	79	71
'44 ..	23 1/2	63·11	56·0	38 3/4	94·6	45·3	43 ‖	115	27·2	—	79	71
'45 ..	30 1/2	61·10	63·7	40	89·2	45·9	43 ‖	139	27·2	—	79	71
'46 ..	48 5/8	63·7	65·11	40	86·6	45·3	43 ‖	137	27·2	—	79 1/4	72
'47 ..	44 7/16	71·9	68·10	40	88·7	50·9	43 ‖	162	49·6	—	80	72
'48 ..	45	90·0	73·4	40	95·8	58·0	43 ‖	207	57·6	—	79	72
'49 ..	49 1/5	99·6	88·3	43 1/2	92·4	58·6	72 1/2	222	61·0	—	103 1/4	88 5/8
Average 1904–13	26 3/4	31 1/2	36	30	25 1/2	18 1/2	24 1/2	78	7 1/4	—	51	44 1/2
1890–99	34	28 1/2	31 1/2	27 1/2	25 1/2	17 1/2	19 1/2	72	6 1/4	—	47	37 1/2
'78–87	50	40	43 1/2	34 1/2	31 1/2	21	25	102	8	—	55 1/2	46
'67–77	58 1/2	54 1/2	56	46	39	26	32 1/2	117	10	—	59	50

Index Numbers (or Percentages) of Prices, the Average of 1867–77 being 100

1922 ..	51·6	88	95	100	103	112	96	111	148	853	150	164
'28 ..	44·0	82	91	87	100	112	118	114	150	854	125	133
'29 ..	40·2	77	91	84	91	95	112	95	143	788	120	132
'30 ..	29·0	63	66	72	72	66	71	79	130	619	124	136
'31 ..	20·4	44	45	50	71	68	48	125	93	544	114	122
'32 ..	19·5	46	49	53	69	74	58	130	93	572	110	118
'33 ..	18·7	42	46	52	73	61	53	74	78	479	103	104
'34 ..	20·0	37	50	50	79	67	60	83	77	503	98	104
'35 ..	26·4	41	56	56	73	72	53	91	88	530	92	98
'36 ..	18·5	56	63	69	75	68	60	125	90	606	92	100
'37 ..	18·4	73	89	88	100	92	82	116	105	745	103	114
'38 ..	17·6	53	70	67	93	81	86	95	106	651	105	116
'39 ..	17·1	39	54	48	81	74	82	100	111	589	103	116
'40 ..	17·1	78	60	53	166	143	122	122	154	898	122	136
'41 ..	18·0	115	57	60	220	157	132	140	236	1,117	122	136
'42 ..	18·1	126	66	76	424	162	132	115	260	1,361	129	136
'43 ..	18·1	128	81	83	288	168	132	95	272	1,247	134	142
'44 ..	18·1	117	100	84	242	174	132	98	272	1,219	134	142
'45 ..	23·1	113	114	87	229	176	132	118	272	1,241	134	142
'46 ..	36·7	117	118	87	222	174	132	117	272	1,239	135	144
'47 ..	33·3	132	123	87	227	195	132	138	495	1,529	135	144
'48 ..	34·1	165	131	87	245	223	132	177	576	1,736	134	144
'49 ..	32·8	183	158	95	237	225	223	190	610	1,921	175	177

* The annual prices are the average monthly or weekly quotations, except potatoes, which are the average weekly quotations during the eight months January to April and September to December.

† Not included in the general average. ‡ Meat (9–13), by the carcase, in the London Central Meat Market.

§ La Plata from 1924. ‖ Argentine maize (Feeding Stuffs); £10 per ton fixed by Ministry of Food.

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Average Prices of Commodities—Contd.

No. of Article	11	12	13	14	15	9–15	16A	16B	17	18A *	18B *	18
	Mutton		Pork	Bacon	Butter		Sugar			Coffee		
Year	Prime	Middling	Large and Small, average	Waterford	Friesland, Fine to Finest	Animal Food Total	British West Indian Refining‖	Beet, German, 88 p. c., f.o.b.	Java, Floating Cargoes §	Ceylon Plantation, Low Middling†	Rio, Good	Mean of 18A and 18B
	d. per 8 lbs.	*d.* per 8 lbs.	*d.* per 8 lbs.	*s.* per cwt.	*s.* per cwt.		*s.* per cwt.	*s.* per cwt.	*s.* per cwt.	*s.* per cwt.	*s.* per cwt.	
1922 ..	125	121 2/5	101	145 1/3	202 1/2	—	15	14 1/8	15 5/16	120 2/3	74 1/3	—
'28 ..	92 1/4	87	77	101 3/4	185 7/8	—	13 1/2	10 1 1/16	11 1/2	143 9/32	81 11/32	—
'29 ..	89 1/2	83	91	116 13/32	180 1/8	—	11 7/32	8 5/16	8 7/8	141 1/8	74 27/32	—
'30 ..	92	86	89	105 5/8	146 13/16	—	8 5/8	5 27/32	6 13/32	106 23/32	42 11/32	—
'31 ..	79	73	65	83 3/8	130	—	7 13/16	5 11/16	6 7/16	101 1/4	33 15/16	—
'32 ..	63	55	54	77	126 3/8	—	7 1/2	5 5/16	5 19/32	105 3/32	54 5/16	—
'33 ..	69	63	60	81 1/2	105 9/16	—	7 5/32	4 23/32	5 1/4	86 25/32	42 1/8	—
'34 ..	74	70	65	90 9/32	79 5/8	—	6 5/32	4 5/16	4 1/16	87 7/32	42 13/16	—
'35 ..	75	70	62	89	92 5/8	—	6 3/16	3 21/32	4 3/4	67 1/16	29 21/32	—
'36 ..	73	68	65	93 27/32	98 21/32	—	6 13/32	3 1/32	4 3/4	58 1/2	30 21/32	—
'37 ..	78	74	68	94	108 3/32	—	7 11/32	5 1/4	6 1/2	75 3/4	36 3/4	—
'38 ..	62	56	69	97 3/16	114 9/16	—	7 1/32	4 5/16	5 15/32	75	19 3/4	—
'39 ..	68	64	70	97 1/4	122	—	9 3/32	6 1/32	7 3/32	73 3/4	22 1/2	—
'40 ..	85	76	96	114 7/8	143	—	9 3/4	—	8 1/8	86 5/16	28 3/32	—
'41 ..	85	76	96	123 11/16	142 11/16	—	9 3/4	—	8 1/8	137 1/2	30 1/4	—
'42 ..	90	78	101	130	143 1/2	—	9 3/4 ‡	—	8 1/8 ‡	130 ‡	28 3/4 ‡	—
'43 ..	96	84	102	142	151 1/4	—	9 3/4 ‡	—	8 1/8 ‡	140 ‡	37 ‡	—
'44 ..	96	84	102	142	151 1/3	—	9 3/4 ‡	—	8 1/8 ‡	140 ‡	37 ‡	—
'45 ..	96	84	102	142	151 1/3	—	9 3/4 ‡	—	8 1/8 ‡	140 ‡	59 ‡	—
'46 ..	100 3/4	81 1/2	97	142	139 3/4	—	—	—	23 1/4	150 ‡	27 3/4	—
'47 ..	101	81	98	124 1/4	126	—	—	—	27 1/2	150 ‡	73 3/8	—
'48 ..	100	81	99	154 3/4	122 3/4	—	—	—	24 1/8	169	79	—
'49 ..	127 3/4	92 13/16	127 3/8	159 1/2	134 1/8	—	—	—	26 1/4	356	145	—
Average												
1904–13	58 1/4	51 3/4	47 5/8	67	113	—	10 1/8	10 7/8	12	75 1/2	43 3/4	—
1890–99	54 1/2	41 1/2	42 3/4	59	100	—	11 1/2	11 1/2	13 3/4	98	62	—
'78–87	64 1/2	53	49	71	116	—	17	18	21 1/2	78	52	—
'67–77	63	55	52	74	125	—	23	24	28 1/2	87	64	—
	Index Numbers (or Percentages) of Prices, the Average of 1867–77 being 100											
1922 ..	199	221	194	196	162	1,286	62		54	* 140	* 116	128
'28 ..	146	158	148	137	149	996	51		40	165	127	146
'29 ..	142	151	175	157	144	1,021	42		31	162	117	140
'30 ..	146	155	171	143	117	992	31		22	123	66	95
'31 ..	125	133	125	113	104	836	29		23	120	53	87
'32 ..	100	100	104	104	101	737	27		20	121	85	103
'33 ..	110	114	115	110	84	740	25		18	100	66	83
'34 ..	117	127	125	122	64	757	22		16	100	67	84
'35 ..	119	127	119	120	74	749	21		17	78	46	62
'36 ..	116	124	131	127	79	763	21		17	67	48	58
'37 ..	124	135	125	127	86	820	28		23	87	57	72
'38 ..	98	102	133	131	92	777	24		19	86	31	59
'39 ..	108	116	135	132	98	808	32		26	85	35	60
'40 ..	135	138	185	155	114	985	42		29	99	44	72
'41 ..	135	138	185	167	114	997	42		29	158	47	102
'42 ..	143	142	194	176	115	1,035	42		29	150	45	98
'43 ..	152	153	196	192	121	1,090	42		29	161	58	109
'44 ..	152	153	196	192	121	1,090	42		29	161	58	109
'45 ..	152	153	196	192	121	1,090	42		29	161	93	127
'46 ..	160	148	187	192	112	1,078	—		82	172	121	146
'47 ..	160	147	188	168	101	1,043	—		96	172	115	143
'48 ..	159	147	190	209	99	1,082	—		85	194	123	158
'49 ..	203	169	245	216	107	1,292	—		92	409	227	318

* Index numbers not included in general average. ‡ Nominal.
† E. India good middling from 1908–1947. Kenya in 1948. § Raw Centrifugals, 96% Pol., from 1924.
‖ White Javas, C.I.F., from 1924.

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Average Prices of Commodities—Contd.

No. of Article	19A *	19B *	19	16–19	1–19	20A	20B	21	22	23	24	25
		Tea		Sugar, Coffee, and Tea	Food		Iron		Copper	Tin	Lead	Coal
Year	Congou, Common *d.* per lb.	Average Import Price *d.* per lb.	Mean of 19A and 19B	Total	Total	Scottish Pig *s.* and *d.* per ton	Cleveland (Middlesbrough) Pig *s.* and *d.* per ton	Bars, Common per ton	Standard £ per ton	Straits £ per ton	English Pig £ per ton	Wallsend Hetton in London† *s.* per ton
1922 ..	8 5/8	14·9	—	—	—	99·10	90·7	11 1/16	63 1/2	162	25 3/8	34 3/4
'28 ..	6 5/16	16·84	—	—	—	69·9	65·9	9 15/16	63 3/4	229 7/16	22 5/16	21 7/16
'29 ..	6 1/16	16·11	—	—	—	74·0	70·3	9 3/4	75 9/16	207 7/16	24 1/32	23 3/8
'30 ..	5 7/32	15·12	—	—	—	76·0	67·0	9 3/32	54 3/4	144 29/32	19 1/2	24 25/32
'31 ..	4 13/16	13·29	—	—	—	71·0	58·6	10 3/32	38 1/8	121 1/8	14 9/32	24 5/8
'32 ..	4 9/32	10·75	—	—	—	68·2	58·6	10	31 31/32	140	13 5/16	23 15/32
'33 ..	6 31/32	11·87	—	—	—	66	62·3	9 1/16	32 21/32	202 1/2	13 1/4	22 5/8
'34 ..	8 21/32	13·20	—	—	—	69·6	66·11	9 17/32	30 5/32	232 1/4	12 13/32	20 1/4
'35 ..	6 23/32	13·06	—	—	—	70·6	67·10	9 5/8	32 3/32	230 15/32	16	20 3/8
'36 ..	6 1/4	13·19	—	—	—	78·6	73·2	10 3/16	37 13/32	207 21/32	19 17/32	23 1/32
'37 ..	6 9/16	14·58	—	—	—	104·6	94·4	12 5/16	54 21/32	246 3/4	24 29/32	24 1/2
'38 ..	6 13/32	14·04	—	—	—	118·0	109	13 1/4	41 21/32	193 31/32	17 7/16	25 1/16
'39 ..	6 7/32	14·18	—	—	—	104·3	100·7	12 3/8	44 1/4	232 15/32	17 3/8	25 11/32
'40 ..	—	15·33	—	—	—	114·10	116·4	14 5/16	62	273 5/16	26 1/2	28 1/16
'41 ..	—	15·13	—	—	—	123	128	15 5/8	62	284 5/16	26 1/2	30 27/32
'42 ..	—	16·25	—	—	—	123	128	15 5/8	62	275	26 1/2	32 1/2
'43 ..	—	18·44	—	—	—	123	128	15 5/8	62	275	26 1/2	34 1/16
'44 ..	—	19·48	—	—	—	123	128	16 1/2	62	300	26 1/2	38 5/8
'45 ..	—	20·06	—	—	—	139·11	140 1/2	18	62	300	29 7/8	42 3/8
'46 ..	—	21·51	—	—	—	167	165·5	19 5/8	77 1/2	321 5/8	47 3/4	45 1/8
'47 ..	—	27·65	—	—	—	176·9	175·4	20 7/16	130 7/8	426 3/4	86 7/8	48 1/8
'48 ..	—	32·21	—	—	—	194·5	193·5	21 1/4	134	547 5/8	97	54 3/4
'49 ..	—	33·72	—	—	—	228·11	204·7	20	132 3/4	603 1/2	104 1/16	54 3/4
Average 1904–13	7 7/8	8 1/8	—	—	—	57 3/4	51 1/2	6 7/8	67 3/4	164 7/8	15 5/8	18 1/8
1890–99	4 5/8	9 3/4	—	—	—	47	41 1/2	5 1/2	50	81	12	17 1/2
'78–87	6 3/4	12 3/4	—	—	—	46	38	5 1/2	55	89	14	16 3/4
'67–77	11 1/4	17 1/4	—	—	—	69	60	8 1/4	75	105	20 1/2	22

Index Numbers (or Percentages) of Prices, the Average of 1867–77 being 100

1922 ..	* 77	* 86	82	326	2,465	148	136	84	154	123	156
'28 ..	56	98	77	314	2,164	105	120	85	219	109	97
'29 ..	54	93	74	287	2,096	112	118	101	198	117	106
'30 ..	46	88	67	215	1,826	111	121	73	138	95	113
'31 ..	42	78	60	199	1,579	100	123	52	115	71	112
'32 ..	38	62	50	200	1,509	98	121	43	131	65	106
'33 ..	58	68	63	189	1,408	99	117	44	193	65	103
'34 ..	77	77	77	199	1,459	106	116	40	221	61	92
'35 ..	60	76	68	168	1,447	107	117	43	219	78	92
'36 ..	56	76	66	162	1,531	118	123	50	198	95	105
'37 ..	58	85	72	195	1,760	154	149	73	235	121	111
'38 ..	58	81	70	172	1,600	176	161	56	185	83	117
'39 ..	56	82	69	187	1,584	159	150	59	221	85	115
'40 ..	—	89	89	232	2,115	179	173	83	260	129	127
'41 ..	—	88	88	261	2,375	195	189	83	271	129	141
'42 ..	—	94	94	263	2,659	195	189	83	262	129	148
'43 ..	—	107	107	287	2,624	195	189	83	262	129	159
'44 ..	—	113	113	293	2,602	195	200	83	286	129	176
'45 ..	—	116	116	314	2,645	217	218	83	286	142	194
'46 ..	—	124	124	352	2,669	258	238	103	306	233	205
'47 ..	—	160	160	399	2,971	273	248	175	406	424	219
'48 ..	—	187	187	430	3,248	300	258	179	521	473	249
'49 ..	—	195	195	605	3,818	336	244	177	575	508	249

* Index numbers not included in the general average.
† Best Yorkshire house after 1916.

† First 9 months only.

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Average Prices of Commodities—Contd.

No. of Article / Year	26 Coal	20–26 Minerals	27 Cotton	28 Cotton	29A Flax	29B Flax	30A Hemp	30B Hemp	31 Jute	32A Wool	32B Wool	33
	Average Export Price	Total	Middling American	Fair Dhollerah ‖	Petrograd ¶	Russian Average Import Price	Manila Fair Roping	Petrograd Clean (*a*)	Good Medium††	Merino, Port Phillip, Average Fleece	Merino, Adelaide, Average Greasy	English Lincoln Half Hogs
	s. per ton		*d.* per lb.	*d.* per lb.	£ per ton	£ per ton	£ per ton	£ per ton	£ per ton	*d.** per lb.	*d.* per lb.	*d.* per lb.
1922 ..	24·16	—	12·10	8	95	84 7/8	33 1/8	57 ‡	30 3/4	39	17 1/8	9 3/4
'28 ..	15·67	—	10·92	8·66	98 1/2	91 15/16	37 11/16	63 13/32	33 1/16	37	17 5/16	17 29/32
'29 ..	16·13	—	10·26	7·73	76 7/16	71 3/32	37 3/32	61	32	35 3/8	13 3/32	16 1/16
'30 ..	16·64	—	7·49	5·12	53 1/8	60 7/32	26 1/2	48 7/32	20	18 9/32	8 3/32	10 3/4
'31 ..	15·98	—	5·90	4·60	36	35 9/16	18 3/4	27 1/2	15 15/16	14·7	7·1	8 1/2
'32 ..	16·27	—	5·24	4·85	45 7/32	42 5/32	18 23/32	36	16 3/32	15·0	7·2	5 25/32
'33 ..	16·08	—	5·54	4·53	51 13/32	48 15/32	15 7/8	37	14 7/8	19·9	9·3	5 29/32
'34 ..	16·08	—	6·70	4·80	60 11/16	50 29/32	14 29/32	42 5/16	14 3/32	21 1/4	10·4	7
'35 ..	16·30	—	6·71	5·42	79 3/8	72 5/16	19 1/32	43 1/4	16 5/16	20·1	9·5	7 11/32
'36 ..	16·98	—	6·71	5·12	63 25/32	60 15/16	28 1/32	42 27/32	17 19/32	24·7	12·2	10 5/16
'37 ..	19·05	—	6·21	4·80	78 13/32	70 3/32	34 5/16	38 3/8	19 1/16	26·9	12·7	16·9
'38 ..	21·32	—	4·93	3·67	66 29/32	63 1/2	21 25/32	38 5/16	17 31/32	18·6	8·9	11·9
'39 ..	21·12	—	5·95	4·41	90 31/32	72 9/16	22 5/16	48 5/16	26 19/32	17·9	9·0	12·2
'40 ..	27·23	—	8·10	6·26	177 1/32	183 1/32	26 3/8	100 13/32	27 3/4	29·6	14·9	19·4
'41 ..	32·22	—	9·14	7·65	200 ‡	—	31 13/16	126 ‡	26 13/32	32	16 1/8	21
'42 ..	34·87	—	8·83	7·37	200 ‡	201·6	33 ‡	130 ‡	24 3/4	32	16 1/8	21
'43 ..	36·91	—	7·83	6·38	200 ‡	205 ‡	33 ‡	130 ‡	33 1/8	32	16 1/8	21
'44 ..	39·19	—	11·32	9·50	200 ‡	205 ‡	40 1/2 ‡	130 ‡	40 1/4	32	16 1/8	21
'45 ..	40·27	—	12·75	10·80	200 ‡	230 (*b*)	40 1/2 ‡	130 ‡	39 1/4	31·6	15·9	21·1
'46 ..	40·94	—	14·87	12·14	252	244 3/8 (*b*)	51	144 1/2	49 1/6	35 3/16	16 3/4	20·7
'47 ..	47·61	—	21·21	16·28	262	248(*b*)	92 1/3	208 1/6	80	58·2	30	22·7
'48 ..	74·07	—	23·23	17·80	274	281·3(*b*)	88 1/3	220 7/16	96 9/16	92 1/8	61 1/8	33
'49 ..	72·97	—	24·85	20·52	283 3/4	244·3(*b*)	105 3/4	177 7/8	101 1/2	92 3/8	65	38 3/8
Average												
1904–13	11 7/8	—	6 1/2	5	32 1/2	36 7/8	30 3/8	31 3/8	18 7/8	17 3/8	9	10 7/8
1890–99	10 3/8	—	4 1/4	3	27	27	26 1/2	25	12 1/2	13 1/2	6 1/2	10
'78–87	9	—	6	4 1/4	33	34	35 1/2	26 1/2	15	18 1/2	8 3/8	11 3/8
'67–77	12 1/2	—	9	6 3/4	46	48	43	35	19	21 1/4	9 7/8	19 3/4
	Index Numbers (or Percentages) of Prices, the Average of 1867–77 being 100											
1922 ..	193	994	134	118	191		116		162	180		49
'28 ..	125	860	121	128	203		130		178	174		91
'29 ..	129	881	114	114	157		126		168	156		81
'30 ..	133	784	83	76	121		96		105	86		54
'31 ..	127	700	66	68	76		58		84	70		43
'32 ..	130	694	58	72	93		70		85	71		29
'33 ..	129	750	62	67	106		68		78	94		30
'34 ..	129	765	74	71	119		73		74	102		35
'35 ..	130	786	74	80	161		80		89	96		37
'36 ..	136	825	74	76	133		91		93	119		53
'37 ..	152	995	69	71	158		93		104	127		86
'38 ..	171	949	55	54	139		77		93	88		60
'39 ..	169	958	66	65	174		91		140	86		62
'40 ..	218	1,169	90	93	383		163		146	142		98
'41 ..	258	1,266	101	113	416		202		139	155		106
'42 ..	279	1,285	98	109	427		209		130	155		106
'43 ..	295	1,312	87	95	431		209		174	155		106
'44 ..	314	1,383	126	141	431		219		212	155		106
'45 ..	322	1,462	142	160	457		219		207	153		107
'46 ..	328	1,671	165	180	528		251		259	167		105
'47 ..	381	2,126	236	241	543		385		421	283		114
'48 ..	594	2,574	258	264	598		396		510	492		167
'49 ..	584	2,673	276	304	562		363		534	506		194

* Port Philip fleece washed nominal since 1895, exactly in proportion with the value of clean wool.
‡ Nominal. ‖ Now No. 1 Oomra, Fine.
¶ Livonian Z.K. from 1921–45. Medium grade continental w/retted from 1946.
†† Lightnings from 1931 to 1942. Daisee ⅔ from 1943.
(*a*) Russian Siretz Group 1, Sort 1 from 1931–33; Jugo-Slav Peasant from 1934–45. Italian S.B. from 1946.
(*b*) Belgian from 1945.

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Average Prices of Commodities—Contd.

No. of Article	34	27–34	35A	35B	35C	36A	36B	37	38	39	40A	40B
	Silk	Textiles		Hides		Leather		Tallow		Oil		Seeds
Year	Tsatlee *	Total	River Plate, Dry	River Plate, Salted	Average Import Price	Dressing Hides	Average Import Price	Town	Palm	Olive	Linseed	Linseed
	s. per lb.		*d.* per lb.	*d.* per lb.	*d.* per lb.	*d.* per lb.	*d.* per lb.	*s.* per cwt.	£ per ton	£ per ton	£ per ton	*s.* per qr.
1922 ..	28¾	—	9⅛	8⅞	8·06	24⅓	36	34⅛	34⅘	75½ †	39½	75½
'28 ..	14	—	15 7/16	11 29/32	12·09	23 1/16	37 7/16	36 15/16	35¾	80 7/16	29⅞	66 15/16
'29 ..	13⅞	—	10 9/16	8¼	10·80	19¼	38¼	36 13/32	34 21/32	72	35 15/32	74⅛
'30 ..	10 15/16	—	6 25/32	6½	7·80	18½	33½	28 23/32	25¼	52⅛	36⅝	61 13/16
'31 ..	8 15/16	—	5½	5 9/16	6·12	17¾	32½	19⅓	19 7/16	53 9/16	18 9/16	38⅞
'32 ..	8 5/32	—	4 9/16	4¾	5·47	17 5/32	28⅞	21 1/16	17⅝	57 3/16	17	38 5/16
'33 ..	6¾	—	5¼	4 11/16	5·65	17 11/32	26 29/32	19 27/32	15 11/16	53 15/16	20¼	39¾
'34 ..	5 7/16	—	4 13/16	4⅞	5·71	17½	25 5/16	17¼	13 17/32	62 3/16	21 13/32	42½
'35 ..	5 5/32	—	5 5/32	5⅛	5·51	17½	25 13/16	24⅝	19⅜	61 13/32	24 13/32	43¼
'36 ..	5 25/32	—	6¼	6	6·47	17½	27 11/32	23 9/32	19 31/32	70 3/16	28½	48 5/32
'37 ..	8 1/16	—	8 21/32	7 9/16	8·62	18 9/32	28 5/16	23 15/32	22 9/16	95 23/32	31⅛	54 11/32
'38 ..	7 31/32	—	6 21/32	5 9/16	6·35	14 5/16	24 1/32	17 13/32	14⅞	68 19/32	26 7/16	46 7/32
'39 ..	13 5/32	—	6¾	6⅛	6·39	18 5/32	23 1/16	16 9/32	14 5/16	73 13/32	29⅛	49 25/32
'40 ..	17½	—	8	8½	8·50	25 7/32	23¾	22 3/32	19	114¼	44 5/32	66⅛
'41 ..	15 21/32	—	7½	8½	8·45	24⅜	24¼	22½	20¾	118	41½	70¼
'42 ..	16 †	—	8⅜	9	9·25	26	26⅛	24 5/16	23	118	44 13/16	78 9/16
'43 ..	16 †	—	8⅞	9 1/16	9·49	27	24 15/16	34⅛	36	118 †	48½	109½
'44 ..	16 †	—	10 1/16	9⅜	10·14	27	28⅞	43½	42¼	118 †	60¾	107½
'45 ..	16 †	—	10 1/16	9⅜	9·42	25	31⅛	43½	42¼	150 †	62	109½
'46 ..	44	—	17⅞	15⅝	11·73	29	38 1/16	46¼	43⅜	270	87⅞	130¾
'47 ..	31⅜	—	22 17/32	19 7/16	21·71	40	58⅝	57⅞	89⅝	330	193¾	211¾
'48 ..	23 9/16	—	20 21/32	20 5/16	20·72	43⅜	64⅝	60	99¼	329	193 17/32	216¾
'49 ..	25¼	—	21 15/16	20 7/16	21·43	45	69 1/16	60	99¼	320	149⅝	197
Average												
1904–13	11¾	—	9⅝	7½	6⅞	16	17	31½	31¼	43¾	26⅝	49½
1890–99	11½	—	6¼	5½	5	13¼	13¾	25	24½	35	19¼	38
'78–87	15	—	8⅝	6¾	6½	15	17	35½	32½	40	23	46
'67–77	23	—	9	7	6⅞	16	18¾	45	39	50	30	60

Index Numbers (or Percentages) of Prices, the Average of 1867–77 being 100

1922 ..	125	1,075	114	174	77	89	151	127
'28 ..	61	1,086	172	176	81	92	161	108
'29 ..	60	976	129	166	64	89	144	122
'30 ..	48	669	92	150	43	65	104	110
'31 ..	39	504	77	146	47	51	108	63
'32 ..	35	513	66	132	44	45	114	61
'33 ..	29	534	68	127	39	40	108	67
'34 ..	24	572	67	123	55	35	124	71
'35 ..	24	641	69	125	52	50	123	75
'36 ..	25	646	82	129	52	51	140	85
'37 ..	37	745	109	134	39	58	192	95
'38 ..	35	601	81	110	36	38	137	81
'39 ..	57	741	84	119	49	37	148	88
'40 ..	76	1,191	109	141	50	49	228	122
'41 ..	68	1,300	107	135	54	53	236	124
'42 ..	70	1,304	116	150	76	59	236	137
'43 ..	70	1,327	120	149	81	92	236	176
'44 ..	70	1,460	132	161	97	108	236	187
'45 ..	70	1,515	129	161	97	108	300	190
'46 ..	193	1,848	199	194	103	111	540	243
'47 ..	136	2,359	277	284	129	230	660	450
'48 ..	102	2,787	271	311	133	254	658	456
'49 ..	110	2,849	279	328	133	254	640	385

* Common New Style from 1921 to 1936. China, Extra "A" from 1937–46; Italian in 1947. † Nominal.

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Average Prices of Commodities—Contd.

No. of Article	41A ‡	41B ‡	41C ‡	41	42	43	44	45A	45B	35–45	20–45	1–45
	Petroleum *				Soda		Indigo	Timber				
Year	Motor Spirit c.i.f.	Kerosene (Burning Oil) c.i.f.	Gas Oil c.i.f.	Mean of 41A, 41B and 41C	Crystals	Nitrate of Soda	Bengal, Good Consuming	Hewn, Average Import Price	Sawn or Split, Average Import Price	Sundry Materials Total	Materials Total	Grand Total
	d. per imp. gall.	*d.* per imp. gall.	*d.* per imp. gall.		*s.* per ton	*s.* per cwt.	*s.* per lb.	*s.* per load	*s.* per load			
1922 ..	15·89	6·32	3·98	—	123	14⅓	9 5/6	46 5/8	117½	—	—	—
'28 ..	5·96	4·48	3·32	—	100	10 31/32	5½	45 7/8	111 5/32	—	—	—
'29 ..	6·75	4·87	3·21	—	100	10¼	5½	44¾	107 21/32	—	—	—
'30 ..	6·52	4·54	3·21	—	100	9 27/32	5½	44½	102 3/16	—	—	—
'31 ..	3·63	3·10	2·33	—	100	9⅛	5½	37 19/32	83⅜	—	—	—
'32 ..	3·97	3·34	2·39	—	100	8⅝	5½	35½	75 1/16	—	—	—
'33 ..	3·43	2·94	2·48	—	100	8 1/32	5½	31 7/8	75 19/32	—	—	—
'34 ..	3·28	2·65	2·45	—	100	7 13/16	5½	31½	79 13/32	—	—	—
'35 ..	3·51	2·88	2·32	—	100	7⅝	5½	32¼	73 5/32	—	—	—
'36 ..	3·77	2·76	2·34	—	100	7⅝	5¾	37 9/16	78 27/32	—	—	—
'37 ..	4·52	3·71	3·14	—	100	7 25/32	5¾	58⅜	103 7/32	—	—	—
'38 ..	4·08	3·49	3·22	—	100	8	5¾	61 3/32	94 5/16	—	—	—
'39 ..	5·00	3·71	3·61	—	100	8⅛	5¾	57 9/16	107 9/32	—	—	—
'40 ..	5·79	5·68	5·31	—	100	9⅞	5¾ †	106 23/32	169 15/16	—	—	—
'41 ..	6·97	5·95	5·93	—	100	13 1/32	5¾ †	191 1/16	214 7/16	—	—	—
'42 ..	7·77	7·00	7·07	—	102½	13½	5¾ †	235⅛	236¼	—	—	—
'43 ..	8·93	7·51	7·61	—	107½	13½	5¾ †	269	246¼	—	—	—
'44 ..	8·31	6·78	6·83	—	107½	15¼	6 †	222 15/16	273 15/16	—	—	—
'45 ..	6·23	5·33	5·38	—	107½	15¼	6 †	190½	235¼	—	—	—
'46 ..	5·81	5·21	5·20	—	107½	16⅛	6 †	184⅞	258½	—	—	—
'47 ..	7·69	6·83	6·52	—	107⅓	17⅞	7 †	187·43	289·20	—	—	—
'48 ..	9·38	8·74	8·69	—	107⅓	19¾	7 †	215·02	352·82	—	—	—
'49 ..	9·61	8·51	7·78	—	107½	20½	7 †	207·09	354·37	—	—	—
Average 1904–13	BASE, 1922			—	60	10⅝	3	38	56	—	—	—
1890–99				—	53	8¼	4⅜	40	45	—	—	—
'78–87				—	62	12½	6	47	47	—	—	—
'67–77				—	92	14	7¼	60	54	—	—	—
	Index Numbers (or Percentages) of Prices, the Average of 1867–77 being 100											
1922 ..	‡ 100	‡ 100	‡ 100	100	134	102	128	143		1,339	3,408	5,873
'28 ..	37	71	83	64	109	78	76	138		1,256	3,202	5,366
'29 ..	42	77	81	67	109	73	76	134		1,190	3,047	5,143
'30 ..	41	72	81	65	109	70	76	129		1,034	2,487	4,313
'31 ..	23	50	60	44	109	65	76	106		890	2,094	3,673
'32 ..	25	53	60	46	109	62	76	97		855	2,062	3,571
'33 ..	22	47	62	44	109	60	76	94		837	2,121	3,529
'34 ..	21	42	62	42	109	56	76	97		839	2,176	3,635
'35 ..	22	46	60	43	109	54	76	92		871	2,298	3,745
'36 ..	24	42	60	42	109	54	79	102		925	2,414	3,945
'37 ..	28	59	79	55	109	56	79	142		1,081	2,821	4,581
'38 ..	26	55	81	54	109	57	79	136		921	2,471	4,071
'39 ..	31	60	91	61	109	58	79	145		964	2,663	4,247
'40 ..	36	90	133	86	109	70	79	243		1,285	3,645	5,760
'41 ..	44	94	150	96	109	93	79	356		1,438	4,004	6,379
'42 ..	49	111	178	113	111	96	79	413		1,564	4,153	6,812
'43 ..	56	119	199	122	117	96	79	452		1,715	4,354	6,978
'44 ..	52	107	172	110	117	109	83	436		1,776	4,619	7,221
'45 ..	39	84	135	86	117	109	83	373		1,753	4,730	7,375
'46 ..	36	82	131	83	117	115	83	389		2,177	5,696	8,365
'47 ..	48	108	164	107	117	128	97	418		2,897	7,382	10,353
'48 ..	59	138	218	138	117	141	97	498		3,074	8,435	11,683
'49 ..	60	135	195	130	117	146	97	493		3,002	8,524	12,342

* Prior to 1922, Kerosene Burning Oil (in barrels), base period 1873–77; from 1922 c.i.f. values per imperial gallon of Motor Spirit, Kerosene (Burning Oil) and Gas Oil, base period 1922.

† Nominal.

‡ Index-numbers not included in the general average.

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REPORT OF THE COUNCIL

For the FINANCIAL YEAR *ended December 31st, 1949, and for the* SESSIONAL YEAR *ending June 21st, 1950, presented at the* ONE HUNDRED AND SIXTEENTH ANNUAL GENERAL MEETING *of the* ROYAL STATISTICAL SOCIETY, *held at the London School of Hygiene and Tropical Medicine, W.C.1, on June 21st, 1950.*

THE Council has the honour to submit its One Hundred and Sixteenth Report.

The Society's Benefaction

Overshadowing all other events of the year was the letter, dramatic in its simplicity, received from the Society's bankers on January 27th, 1950. "We beg leave to inform you that we have to-day received the sum of £30,000 for the credit of the Society's Account. The sender has directed us to divulge no names as this gift is being made anonymously." It was made known to the Council at the same time that the sole condition attaching to this benefaction was that it be devoted exclusively to the housing of the Society. Meeting on January 31st, 1950, the Council recorded its profound gratitude for a generosity that was, in its magnitude, unique in the history of the Society. It welcomes the opportunity offered by this, its 116th Annual Report, of publicly expressing, on behalf of every Fellow, its deep appreciation of this gift.

The Council at once appointed a Committee to consider and advise how best to use this benefaction. It also took steps to inform all Fellows, at home and abroad, of this wholly unexpected and momentous event, and to acquaint other persons and organizations who would, it believed, be interested to learn of the Society's good fortune. The letters of congratulation and goodwill that it has received in answer to the announcement—not only from Fellows in Great Britain but also from India, Spain, Holland and the U.S.A.—have been a source of much encouragement to the Council in its endeavours to solve the Society's major problem. In particular it would like to quote from a letter from the President of the American Statistical Association:—"On behalf of the officers and members of the American Statistical Association, I wish to extend our congratulations to the officers and members of the Royal Statistical Society on receiving this richly-deserved gift. It is a most fitting tribute to the national and international leadership of your Society in the development of statistical science for more than a century. Those of us of the American Statistical Association who may be visiting England from time to time will look forward to visiting your Society's new home when it is established." Much, needless to say, still remains to be done before the Society can acquire a home that it can regard as worthy of its history and traditions, but not least amongst its present pleasures is to be able to look forward to the day when it can fittingly receive its Fellows and guests from home as well as from abroad.

Number of Fellows

During the calendar year 1949 the number of new Fellows elected into the Society (including a few former Fellows restored to the roll) was 189. With losses by death and withdrawal numbering 103, the net increase was 86 compared with figures of 142, 188 and 231 in the three preceding years. As a result of these entries and exits, the number of Fellows on the roll was 2,064 at the end of December, 1949. Elections and losses up to May 1st of the present year brings the total at that date to 2,208, almost precisely double the pre-war figure of 1,108 in 1939.

Calendar Year	Number of Fellows (excluding Honorary Fellows)		
	Lost by death, withdrawal or default	Elected, or restored to the roll	On the roll at December 31st
1939	39	64	1,108
1940	76	47	1,079
1941	65	60	1,074
1942	69	74	1,079
1943	61	121	1,139
1944	29	159	1,269
1945	29	177	1,417
1946	56	287	1,648
1947	75	263	1,836
1948	96	238	1,978
1949	103	189	2,064

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A fundamental aim of the Society has always been to provide a forum for discussions on the development of statistical methods and their application, whatever the field of application may be. It has endeavoured to bring and hold together, to the benefit of all, the mathematical statistician and the arithmetician, the research worker and the administrator, the statistician in industry and the statistician in government service, the technically trained and qualified worker and the amateur with, perhaps, little grasp of methodology but an innate gift of seeing what lies behind his figures; and so on, over the wide range incorporated under the one ill-defined heading "statistician." The still increasing Fellowship and the low rate of withdrawals suggest that this policy is being successfully applied, a conclusion which, naturally, the Council draws with satisfaction. The Society's new home, when acquired, should do still more to weld together the wide and diverse nature of its Fellowship. At the same time it must not be overlooked that rising costs of housing, administration and, in particular, printing, are likely, in the next few years at least, to tax the Society's resources to the utmost. Most of its income must come from annual subscriptions, and the Council therefore earnestly hopes that, with the help of Fellows (and that help is an essential), the Society's "net reproduction rate" may continue to be held at a figure well above unity.

In addition to the number of ordinary Fellows given in the table above there were, at December 31st, 1949, 14 Honorary Fellows, of whom 7 were Presidents for the time being of other Societies concerned with the advancement of statistical knowledge. The ordinary Fellows at the end of 1949 included 102 representing corporate bodies or institutions.

The Council has in the current year re-published the list of Fellows. It would remind Fellows that this list can serve its purposes effectively only if they will themselves notify promptly any changes either of description or address. Every Fellow is, therefore, asked to check the entry relating to him or herself and, if he has not previously done so, to inform the Assistant Secretary immediately of any correction or addition that is required. This list includes Fellows elected up to December, 1949. The names and addresses of Fellows elected between January and May, 1950 (inclusive), are specially given in Appendix A to this Annual Report, and form an almost up-to-date supplement to the published list.

Losses by Death

The Council regrets to report that during the year ending May 1st, 1950, the Society lost by death the undermentioned Fellows:—

	Date of election
Verrijn Stuart, C.A. (Honorary Fellow)	1904
Chappell, Edgar L.	1921
Franklin, Ernest L.	1919
*cp**Greenwood, Major, D.Sc., F.R.C.P., F.R.S.	1909
**Green, Ernest Redford Garner	1918
Hodgkinson, Noel Alexander	1936
**Keynes, John Neville, M.A., Sc.D.	1883
**Laughton, A. M., F.I.A., F.F.A.	1910
**Leake, Percy Dewe, F.C.A.	1905
Mitchell, Sir George A., D.L., LL.D.	1929
**Moon, E. R. P.	1899
Myles, William Harris, M.B.E., M.A.	1920
Oldmeadow, Ernest James Francis	1948
**Price, L. L. F. R., Hon. LL.D.	1887
Sen, Dinendu Mohan, B.Sc.(Econ.)	1946
Wolfe, Lee J.	1909

* Life Fellow.

c Served on Council.
p Contributed to *Proceedings*.

Professor Verrijn Stuart became Director of the Central Statistical Bureau of the Netherlands at the early age of 33. He was subsequently appointed professor of political economy at the University of Groningen, and later held for 17 years the corresponding chair in the University of Utrecht. As Secretary-General and member he played an important part in the work of the International Statistical Institute between 1899 and 1938, and at its meetings and elsewhere exercised over this long span of years a very considerable influence in international statistics.

Professor Major Greenwood, professor emeritus of epidemiology and vital statistics in the University of London, was one of that small but highly distinguished band of the Society's Fellows who have combined a training in medicine with the use of statistics—William Farr,

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William Guy, T. H. C. Stevenson, John Brownlee, to name but some of his famous predecessors. Keen of vision and, when the occasion justly demanded, keen of pen and tongue, he sought to advance for almost half a century the application of exact statistical methods to the many, and many-sided, problems of the art and science of medicine. In turn councillor (1912 to the time of his death), honorary secretary (1919–34), and president (1934–36), he served the Society, for which he had a very great affection, uninterruptedly for nearly 40 years. In 1945 the Society awarded him its highest and jealously-guarded distinction, the Guy Medal in gold.

Dr. J. N. Keynes, dying at the age of 97, had been a Fellow for 66 years, and in length of Fellowship (though not, in fact, in age) was the "Father" of the Society. Known in early life for his teaching and books on logic and political economy and in later life for his work in university administration, his influence was long brought to bear on Cambridge students, and earned him an Honorary Fellowship of Pembroke and, on his retirement, the title of Registrary Emeritus.

Mr. P. D. Leake, who died at the age of 88, was an eminent chartered accountant and a writer of distinction on practical economics and accountancy particularly in relation to joint stock companies.

Vice-Presidents

For the Session 1949–50 the President appointed as Vice-Presidents of the Society Professor R. G. D. Allen, Mr. H. Campion, Professor A. Bradford Hill and Sir George Maddex.

Meetings of the Society

The following papers have been read during the Session at Ordinary General Meetings of the Society which have been held at the London School of Hygiene and Tropical Medicine:—

1949	
October 31st	HEYWORTH, Sir GEOFFREY. Presidential Address on the Use of Statistics in Business.
December 8th	KENDALL, Professor M. G. The U.K. Mercantile Marine and Its Contribution to the Balance of Payments.
1950	
January 20th	TOBIN, JAMES. A Statistical Demand Function for Food in the U.S.A.
February 22nd	GRAY, P. G., and CORLETT, T. Sampling for The Social Survey.
March 22nd	A Discussion on Colonial Statistics, opened by SEARLE, W. F., PHILLIPS, E. D., and MARTIN, C. J.
April 26th	MENZLER, F. A. A. London and Its Transport System.
May 17th	REDDAWAY, W. B. Movements in the Real Product of the U.K., 1946–49.

At some of these meetings the numbers of Fellows and guests present have been very large. While these numbers have, so far, been comfortably within the capacity of the main lecture theatre of the London School of Hygiene and Tropical Medicine, they have sometimes been less comfortably within the estimated demands for tea or galley proofs of the paper to be read. The Council would, however, add that its Honorary Officers are now investigating ways and means of assessing the "drawing" capacity of a paper so that for each meeting a satisfactory but not wasteful provision may be made (though the statistical problem does not appear to be an easy one to solve).

The Council would remind Fellows that it welcomes suggestions on subjects to be discussed at meetings and, still more, the submission of papers for reading. In the present session it was particularly happy to be able to arrange in March, 1950, a discussion on colonial statistics to coincide with the conference of colonial statisticians then taking place in London. Many Fellows at work in diverse fields in this country will have learnt for the first time of the difficult problems which their colleagues overseas have to face, and the admirable efforts that are being made to overcome them and to produce accurate statistical data.

The Research Section

Professor M. G. Kendall has served during the current Session as Chairman of the Research Section. Mr. E. C. Fieller has continued as Honorary Secretary, and the other members of the Section's Committee have been: Mr. F. J. Anscombe, Professor G. A. Barnard, Dr. H. E. Daniels, Dr. O. L. Davies, Mr. D. G. Kendall, Dr. C. A. B. Smith, Mr. R. L. Plackett and Dr. L. Solomon, with Professor M. S. Bartlett and Mr. P. Lyle nominated by the Council, and Dr. J. O. Irwin, Mr. Richard Stone and Dr. F. Yates *ex officio* members as Editors of Series B of the *Journal*.

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During the Session four ordinary meetings have been held, at which the following papers were read:—

1949
November 25th . Ross, Professor A. S. C. Philological Probability Problems.

1950
January 27th . KENDALL, Professor M. G. Factor Analysis as a Statistical Technique.
BABINGTON-SMITH, B. An Evaluation of Factor Analysis from the Point of View of a Psychologist.

March 29th . (Symposium on Ranking Methods):
MORAN, P. A. Recent Developments in Ranking Theory.
WHITFIELD, J. W. Uses of the Ranking Method in Psychology.
DANIELS, H. E. Rank Correlation and Population Models.

June 1st . . HAMMERSLEY, J. M. On Estimating Restricted Parameters.

In addition, the Research Section, acting on behalf of the Society, held on October 14th, 1949, a special meeting at which Dr. Gertrude Cox read a paper on "The Organization and Functions of the Institute of Statistics of the University of North Carolina." It was a particular pleasure to the Council to have this opportunity of welcoming through the Research Section so distinguished a visitor. Overseas visitors who have taken part in other meetings of the Section have included Professor Harald Cramér of the University of Stockholm, Dr. J. E. Kerrich of the Witwatersrand University, and Professor J. Neyman of the University of California.

The Council wishes to remind Fellows that the Research Section Committee welcome offers of papers for reading at the Section's ordinary meetings; the papers should in general make either some novel application or some extension of existing statistical theory.

The Industrial Applications Section

A Section Committee has continued to guide the work of the Industrial Applications Section, co-ordinating the activities of the separately organized Local Groups and linking them with the Society. This Committee has consisted of three members appointed by the Council (Dr. B. P. Dudding, Mr. E. C. Fieller, and Mr. W. J. Jennett), three members appointed by the 1948–49 Section Committee (Professor G. A. Barnard, Mr. D. J. Desmond and Miss J. Keen), and two representatives of each Local Group. Mr. G. H. Jowett was elected Chairman, and Miss Keen the Honorary Secretary.

The main activity of the Section has been the discussion meetings of Local Groups, as arranged by the Group Committees. The Officers of these Committees were:—

Group	*Chairman*	*Honorary Secretary*
Birmingham and District . .	Dr. J. W. Rodgers	Mr. B. J. A. Martin
London	Mr. A. Blackwell	Mr. E. D. Van Rest
Sheffield	Mr. W. F. Higginbotham	Mr. G. H. Jowett
North-Eastern	Mr. N. J. Squirrell	Mr. J. B. Nadauld
Tees-side (Sub-Group) . . .	Mr. H. Kenney	Mr. J. T. Richardson
South Wales	Dr. T. V. Starkey	Mr. E. Lloyd

At the end of 1949 the total membership of the Section remained at slightly more than 500, this number including 320 Fellows. During the Session 40 discussion meetings have been held, 7 in London and in Sheffield, 6 in Birmingham and in Newcastle, 4 in Norton-on-Tees and in Crumlin (Mon.), 3 in Middlesbrough, and 1 in Newport, Usk and Cardiff.

The subjects for discussion have been as follows—

Birmingham and District Group

1949
September 30th . Statistics as an Aid to Productivity—J. W. Rodgers.
October 26th . The Setting Up of a Statistical Department—A. S. Wharton.
November 23rd . The Extension of Statistical Methods in Production Engineering—T. U. Matthew.

1950
January 25th . Statistical Quality Control Applications—W. A. Bennett.
February 22nd . Specifications and Tolerances—D. J. Desmond.
March 22nd . . Graphs and Correlation—D. G. Beech.

London Group

1949
October 7th . . The Control of Quality in Electronic Tube Manufacture—E. A. G. Knowles.
November 4th . A Symposium on the Repeatability and Reproducibility of Test Results—R. Claxton, A. H. Dodd, J. R. Fraser, R. G. Newton and A. E. Worley.
December 2nd . Factorial Designs in Engineering—P. Eisenklam.

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1950
February 2nd . (Joint Meeting with the Institute of Engineering Inspection). A Survey of Present Methods of Industrial Statistics—B. P. Dudding.
March 3rd . . Flexible Methods in Control Charts and Sampling Inspection—G. A. Barnard.
March 31st . . A Problem in the Control of Position of Valve Base Pins—E. C. Fieller.
May 5th . . Experimental Designs and Their Practical Application—D. R. Read.

North-Eastern Group

1949
October 13th . Statistical Aids to Industrial Administration—L. H. C. Tippett.
November 23rd . The Presentation of Sampling Data as a Guide to Executive Action—B. P. Dudding.
1950
January 18th Graphs and Correlation—D. G. Beech.
February 15th . Man-machine Relationships—L. T. Wilkins.
March 15th . . Fuel Consumption in a Re-heating Furnace—A Study in Regression—G. H. Jowett.
April 19th . . Specifications and Tolerances—D. J. Desmond.

Tees-side Sub-Group

1949
October 11th . Operational Research in War and Its Extension to Industry—T. A. Evans.
November 8th . A Study of Road Traffic Problems—J. G. Wardrop.
December 13th . Experimental Design—G. E. P. Box.
1950
January 10th . Increasing Efficiency in American Steel Plant Operations—D. R. G. Davies.
February 14th . Man-machine Relations—L. T. Wilkins.
March 14th . . Continuous Processes—How to Interpret the Effects of Several Variables which Operate Simultaneously—G. H. Jowett.
April 11th . . Investigation of Water Gas Plant Efficiency—F. L. Clark and J. T. Richardson.

Sheffield Group

1949
September 29th . The Application of Statistical Methods in American Steel Plants—D. R. G. Davies.
October 27th . A Symposium on the Scope of Statistics—A Control Chart in the Foundry—W. J. Colton. The Use of Statistics in Safety-in-Mines Research and Testing Branch-J. G. Davies. Statistics and Some Properties of Coal—P. H. Price. An Application of Statistics to Price Estimating—J. Russell.
November 10th . The Teaching of Statistics—Symposium jointly with the Sheffield Mathematical Society.
1950
January 25th . Statistics and the Craftsman—J. Keen.
February 23rd . Debate on "That Statistical Methods Should be Introduced from the Top Downwards"—A. W. Swan and N. H. Bacon.
March 30th . . Variability in Chemical Analysis—A. H. Dodd.
April 27th . . Statistics and the Business Man—W. Higginbotham.

South Wales Group

1949
October 14th . The Use of Statistics in Psychological Testing—J. W. Cox.
November 11th . The Use of Statistical Method in Steel Plants in the U.S.A.—D. R. G. Davies.
December 9th . The Use of Calculating Machines in Statistical Computing—J. C. P. Miller.
1950
February 10th . The Application of Statistical Method in Agriculture—M. R. Sampford.
The Design of Experiments—M. R. Sampford.
March 10th . . Some Problems in the Measurement of Regional Incomes—J. Buckatzsch.
April 21st . . The Application of Probability and Statistical Method to Electricity Supply—R. B. Rowson.

The Study Section

The Committee of the Study Section for the session has been—Chairman, Mr. W. R. Buckland; Honorary Secretary, Mr. L. T. Wilkins; Council Members, Miss J. I. Douglas, Mr. R. F. George; other members, Mr. A. Blackwell, Mr. J. I. Mason, Mr. C. A. Moser, Mr. E. Shankleman.

During the session the Section has held seven meetings for the purpose of discussions and papers, and an Annual General Meeting at which an account of sources and an appreciation of recent literature in various fields of statistics was given by members of the Section Committee. These eight meetings have been as follows:—

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1949

October 12th . The Census of Distribution—W. E. Clibbon, J. Baxter, L. T. Wilkins.
November 9th . Organization of a Statistics Department—G. Browne.
December 14th . Problems of Election Prediction—H. Durant.

1950

January 3rd . . Some Problems in Demography—E. Grebenik.
February 8th . Gross Investment in Inland Transport—K. F. Glover.
March 8th . . Some Problems of Sampling in the Brewing Industry—Miss S. V. Cunliffe.
April 12th . . The Uses of Calculating Machines for Statistical Computations—D. C. Gilles.
May 10th . . Annual General Meeting—Review of Literature.

The very great increase in attendances at the Section's meetings reported in the Council's last Annual Report has not been sustained during the current session. The average attendance has dropped to 40 from last year's average of 54. The level of interest in the proceedings has, however, been fully maintained.

In addition to these eight meetings held in London, a new venture this year was a provincial meeting held in Bristol on January 26th, 1950. This meeting took the form of an Open Forum on the subject "The Use and Teaching of Statistics." Some 100 persons were present, and the meeting led to proposals for the formation of a local study group in Bristol. As a result a sub-Committee has been formed, the chairman of which will be a member of the Study Section Committee.

Also during this session the Sheffield Group of the Industrial Applications Section held a joint meeting with the Sheffield Mathematical Society to discuss the "Teaching of Statistics." The Honorary Secretary of the Study Section, Mr. Wilkins, attended this meeting as a representative of the Committee and Section. The Council, both on its own behalf and on behalf of the Study Section, would like to record its appreciation of Mr. Wilkins's work as Honorary Secretary of this Section, and thank him for his attendance at these two important provincial meetings.

The Study Section and the London Group of the Industrial Applications Section have again been fortunate in being able to hold their meetings at the Lighting Service Bureau of the E.L.M.A., to whom the Council expresses its sincere gratitude.

Guy Medal

The Council has pleasure in reporting that, acting on the recommendation of its Executive Committee, it has awarded a Guy Medal in Silver to Mr. H. Campion for his paper on International Statistics read before the Society on January 19th, 1949. The Council welcomes this opportunity of paying tribute to the Director of the Central Statistical Office and to his successful work in the national as well as the international field of statistics. The establishment of this Office has realised a wish which had long been dear to the Society.

Frances Wood Memorial Prize

The Council has offered the Frances Wood Memorial Prize for competition this year for, as customary, the best investigation, on statistical lines, of any problem bearing directly or indirectly upon the economic or social conditions of the people. Entrants must have been under the age of 30 on January 1st, 1950. They have until December 31st, 1950, in which to prepare and submit their essays.

The Society's Examinations

An examination for the Society's Certificate was held on March 31st and April 1st, 1950. Thirty candidates presented themselves for all or part of the examination. The following nine Fellows were awarded Certificates—

Baron, Raymond V.
Cooper, Ronald A.
Georgiades, Lefkos P.
Neall, Peter S.
Nicholson, Thomas W. J.
Oades, Reginald C.
Thom, Jean M. S.
Thompson, John F.
Williams, Iris E.

No candidates presented themselves for the Diploma examination. The next examinations will be held in April, 1951. The Certificate examination of 1950 was held in the Department of Medical Statistics at the London School of Hygiene and Tropical Medicine, and the Council has once more to acknowledge its gratitude to the School for these facilities, and to Professor

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Bradford Hill and his colleagues for help in conducting the examinations. It also extends its thanks to its Examinations Committee and others who have assisted the Committee in carrying out its task. The membership of the Committee has been: Dr. D. Heron (Chairman), Professor R. G. D. Allen, Dr. D. J. Finney, Mr. R. F. George, Dr. H. O. Hartley, Professor E. S. Pearson, Mr. Richard Stone.

The Journal

During the year the Society has continued to publish in Series A articles on the statistics of various branches of trade, industry, commerce and sociological subjects, and six of these articles have now been issued. Many more are in hand. Written by experts in each field, they make, the Council believes, an important contribution to the general statistical knowledge of this country, and will lead to the more informed use of statistics in economics, industry and sociology. The Council is greatly indebted to those who have undertaken to provide articles, and to Professor M. G. Kendall for his general administration of the scheme.

Further steps have been taken during the year to speed up the issue of Series A of the *Journal* so that it may once more appear regularly and without undue delay. Fellows will have observed that a real degree of success in this has been achieved. For instance, Part I, 1950, will contain the President's address of October 31st, 1949, and the paper read before the Society on December 8th, 1949. This part would ideally have appeared in February, 1950, and will, it is hoped (at the time of the writing of this report), be published in June. In other words the delay of nearly two years that resulted from the war has now been reduced to about four months, and every attempt is being made to make it still less.

For the editing of Series B of the *Journal* an editorial panel (with power to co-opt) has, during the year, been constituted as follows: Dr. J. O. Irwin (Chief Editor and Chairman), Mr. F. J. Anscombe, Professor G. A. Barnard, Professor M. S. Bartlett, Dr. H. E. Daniels, Dr. O. L. Davies Mr. E. C. Fieller, Dr. H. O. Hartley, Mr. D. G. Kendall, Professor M. G. Kendall, Dr. C. A. B Smith, Mr. Richard Stone and Dr. F. Yates.

Vol. XI, Parts I and II (1949) have been published during the year, and Vol. XII, Part I (1950) is in the press. The papers read at the Symposium on Stochastic Processes and the account of the discussion which followed mark an important advance in statistical methodology.

The Library

The services given to Fellows and others authorized from time to time to use the Library during 1949 are summarized as follows, the figures in brackets giving the corresponding numbers in 1948 and 1947 respectively. The number of persons who borrowed books was 345 (366, 385), and between them they made 1,169 (1,229, 1,534) effective applications, borrowing 2,032 (2,314, 2,691) volumes.

The number of signatures of Fellows and visitors using the reading room in 1949 was 586 (603, 667). It is probable, however, that not all those using the reading room enter their names in the signature book, and to ensure a more accurate record, the attention of Fellows and visitors is drawn to this requirement.

Non-serial works added to the Library during the year numbered 537 (429, 317). The number of books added has been, it will be observed, increased by over a hundred in each of the last two years. In the current year the Council's Library Committee has, in fact, made a special study of all requests made for books, etc., which could not be met from the Library's resources. Whenever in the Committee's opinion the request was one which the Society's Library could properly be expected to meet, the book in question has been ordered.

In the Council's last Annual Report, Fellows were invited to offer their views upon the opening of the Library to a late hour in the evening. Though no appreciable response was made, the Council nevertheless during the past session twice arranged for the Library to be kept open during the evening—till 8.30 p.m. The first "experimental" period was January, 1950, when the later opening was in operation on each Monday of the month (5 nights). Only eight Fellows used the Reading room during these hours (five on one occasion and three on more than one, with a total of 17 visits). The second "trial" took place in April, 1950, when the Library was on Thursdays kept open till 8.30 p.m. and on three nights. On this occasion three Fellows used the Library after ordinary hours and made six visits. In view of the Society's lack of staff, this demand is not sufficient in the Council's opinion to justify the closing of the Library by day to allow an evening opening—but it would again welcome the views of Fellows.

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The Council has been much more concerned with the general inadequacy of its Library facilities. By reason of the very limited accommodation available these inevitably fall far short of what should be provided by the most comprehensive statistical library in the country. Furthermore, it is almost 30 years since a complete catalogue of the contents of the Library was made, and the need for bringing it up-to-date is both obvious and urgent. It is hoped that with the assistance of the benefaction for housing the Society accommodation worthy of the Library will become available, and this important requirement is being fully borne in mind. Even, however, with adequate accommodation, considerable expense must be incurred in providing suitable furniture and equipment, while the preparation of a complete catalogue will be an expensive undertaking which cannot be met out of the benefaction. Special efforts will have to be made in the near future to find from the Society's own resources, or elsewhere, the money necessary for these essential purposes.

Housing

In its last Annual Report the Council informed Fellows that it had directed to the President of the Royal Society a letter setting out the claims of the Royal Statistical Society to inclusion in the proposed scheme for housing scientific societies on some central site. This letter had been signed by the seven Fellows of the Royal Society who were Fellows of the Royal Statistical Society, and also by the President and Senior Honorary Secretary. Late in 1949 the Council was, to its great satisfaction, informed by the President of the Royal Society that the Royal Statistical Society's claims had been accepted and that, therefore, it would be included in any building scheme on a central site. The benefaction subsequently made to the Society has, of course, changed the position radically. Nevertheless in view of the difficulties of finding a suitable building in central London, the Council has thought it right not to withdraw from its accepted position in the central site scheme. It hopes, however, that armed with its munificent benefaction it may be possible to attract to the Society still further help that will allow it, literally, to put its house in order. All this is being actively pursued by the Council's Benefaction Committee, but so far no appropriate building has been found.

Finance

Abstracts of the Honorary Treasurer's Accounts, viz. the statement of Income and Expenditure for the year and the Balance Sheet as at December 31st, 1949, together with the Auditor's report thereon, are contained in Appendices B and C.

Income, excluding Life Composition Fees, increased from £7,806 in 1948 to £9,238 in 1949, while expenditure increased from £7,234 to £8,585. The surplus of £572 in 1948 was thus increased to £653 in 1949.

The two main sources of income are Fellowship subscriptions and sales of the Journal. The former increased from £4,350 to £4,715 and the latter (Series A and B) from £2,606 to £3,623, The two main items of expenditure are, (*a*) salaries and wages, and (*b*) expenses incurred in the publication and distribution of the Journal. The former increased from £1,733 to £1,813 and the latter from £2,921 to £4,390. It should be observed, however, that five parts of the Journal, Series A, were published during the year. On the other hand, expenditure on stationery and miscellaneous printing decreased from £672 to £253, the explanation being that the expenditure for 1948 included the cost of printing (£337) the 1948/49 edition of the List of Fellows.

Attention may be drawn to the fact that while the total income from sales of the Journal (Series A and B) reached the sum of £3,623 (representing an increase of £1,017) the expenditure upon publication and distribution exceeded that income by £767.

Composition Fees fell from £429 in 1948 to £236 in 1949 and at the end of the year the Composition Fee Fund, which was maintained at the total of composition fees received from Fellows still living, amounted to £6,882. The composition fees (£126) of compounders who died during the year, together with the surplus of income over expenditure of £653, was added to the Consolidated Fund, which amounted to £7,642 at the end of the year.

The Council and Officers

Acting under the Society's Bye-laws the Council gave opportunity to Fellows to make suggestions for the composition of the Council for the session 1950–51. It took into account all the suggestions received and adopted nearly all of them. The Council's recommendations were circulated to all Fellows, and as no alternative proposals were received, the Fellows named below

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will be announced at the Annual General Meeting on June 21st, 1950, as having been elected as President, other officers and other members of Council for the session 1950–51.

The Council, on behalf of the Society, has, with great regret, to bid farewell to Sir Geoffrey Heyworth. As one of the Society's distinguished "external" presidents he has, in spite of his numerous public and business commitments, shown a regard for its interests and a readiness to help advance them that has more than fully met the exacting standard set by his predecessors. The Council has no doubt, too, that it will be allowed to seek the advice and accumulated wisdom of yet another ex-President, an asset which is not the least amongst the Society's hidden reserves.

Professor J. H. Jones has watched over the Society's finances for the past three years, and for his discharge of that duty the Society is deeply indebted to him. Mr. R. F. Fowler now succeeds him as Honorary Treasurer. Professor Bradford Hill has served as Honorary Secretary the maximum term of ten years allowed under the Bye-laws. During the tenure of his office he has encountered as difficult a period as has fallen to the lot of any previous Honorary Secretary. The war created many unprecedented problems, and the development of the Society in numbers and activities during the post-war years gave rise to further complexities. The Council wishes to record its sincere appreciation of the assiduous and devoted services rendered to the Society by Professor Bradford Hill during the period of his Honorary Secretaryship. It was unanimous in recommending him to the Society as President for 1950–51.

President

A. Bradford Hill.

Council

M. S. Bartlett.
B. Benjamin.
W. R. Buckland.
H. Campion.
D. G. Champernowne.
Sir Henry Clay.
W. Manning Dacey.
D. J. Desmond.
Iris Douglas.
B. P. Dudding.
E. C. Fieller.
R. A. Fisher.
H. O. Hartley.
*J. O. Irwin.
J. H. Jones.
*M. G. Kendall.
A. H. Marshall.
†F. A. A. Menzler.
E. S. Pearson.
J. H. Richardson.
†J. Ryan.
L. G. K. Starke.
Percy Stocks.
†A. W. Swan.
L. H. C. Tippett.
*J. Wishart.

Honorary Treasurer

R. F. Fowler.

Honorary Secretaries

R. F. George. Richard Stone. Philip Lyle.

Honorary Foreign Secretary

R. F. George.

On behalf of the Council,

GEOFFREY HEYWORTH,
President.

A. BRADFORD HILL
R. F. GEORGE
RICHARD STONE
Honorary Secretaries.

1st June, 1950.

Those marked * were not Members of Council during the preceding session, and those marked † have never previously served on the Council.

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APPENDIX A

From June, 1949 to May, 1950, inclusive, the candidates named below were elected Fellows of the Society:

June–December, 1949:

Adair, Jane Biggar Graham.
Adams, Alec Harold.
Angurli, Fouad.
Anson, Cyril Joseph.
Arumugam, P. S.

Badcock, Ernest Hopwood.
Bailey, James Albert.
Bailey, Norman Thomas John.
Barker, Keith Lambert.
Barnard, Lionel Edward.
Bateman, Gertrude Isabella.
Beale, John.
Berent, Jerzy.
Blake, Archie.
Blanco, Enrique Loizelier.
Bound, John Arthur.
Brooksbank, Edward Constable.
Brown, James.
Burgess, Geoffrey Riddle.
Butler, John Douglas.

Castle, Olive Mary.
Chang, Chan Hoey.
Cox, Henry James.
Cozens, Philip.
Cresswell, William Louis.
Crombie, Albert Douglas.

Dashwood, John Russell.
Davies, Mary.
Day, David James.
Downing, Peter Greenslade.
Dunn, Anthony Thomas.

Faulkner, Thomas Ewan.
Freeman, Geoffrey Harry.

Gallia, George.
Gamble, Walter Howitt.
Ganguli, Jalesh Chandra.
Gatherer, William.
Glaskin, Alec.
Glover, Kenneth Frank.
Gold, Daniel.
Gordon, Kenneth Charles Thomas.
Gray, Jane.
Grobstein, Isador.

Hartrey, Norman Kenneth.
Haydon, Gerald Vernon.
Huzurbazar, Vasant Shankar.

Jennings, Eric Delaware.
Jones, Thomas Cledlyn.

King, Graham Willocks.
Knowelden, John.

Lal, Dip Narayan.
Lane, Percy Jack.
Lau, Dieter Walter.
Lim, Tay Boh.
Livesey, Eric Francis.
Lubin, Ardie.

McArthur, Norma R.
McCullen, John Donald.
Mackenzie, Joseph Percy.
Maddison, Arthur Eric.
Manley, Claud Victor.
Mehta, Batuk Hiralal.
Mellor, Hugh Wright.
Mogford, Cynthia.
Molony, John Patrick.
Moshkowitz, Freda.
Moustafa, Madany Disouky.
Munden, Alick Robert.

Neall, Peter Stinson.
Noah, Christian Emmanuel Abiodun.

Papafilis, Nicholas.
Parr, Frank Douglas.
Parsons, James Watson.
Peggs, Alfred Deans.
Penrice, Geoffrey.
Pinshow, Leonard.
Pope, James Albert.
Potts, Tom.
Purser, Anthony Francis.

Rajchenbaum, Niuma Benjamin.
Reah, George Robinson, Jr.
Rew, Frederick William.
Richards, William David.
Robson, Reginald Arthur Henry.
Roy, Andrew Donald.
Russell, Marion Howard.

Sadek, Fernando Habib.
Sampson, William John.
Sanjana, Kershasp Firozsha.
Shankara, Shiva.
Shrimpton, Thomas E.
Sivarama-Murthy, Puranapanda Venkata.
Skellam, John Gordon.
Smith, James Vivian.
Stevenson, Peter.
Stuart, Alan.

Tate, Alfred Eric.
Trott, Eric Magarey.

Walpole, Robinson Edgar.
Walsh, Leonard Peter.
Williams, Iris Elizabeth.
Williams, James Oladipo.

Corporate Representatives

Baker, Edward Cecil, *representing* G.P.O. Headquarters Library.
Benson, James. *representing* Kemsley Newspapers Ltd.
Bullus, Eric Edward, *representing* The London Municipal Society.
Lord, Albert, *representing* The Printing, Packaging and Allied Trades' Research Association
Svec, Dr. Karel V., *representing* Czechoslovak Ministry of Foreign Trade.

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January–May, 1950:

Agamieh, Mohamed M., 1, Ben Soukary St., Rodah Island, Cairo, Egypt.
Ali, Iftikhar, B.A.A. Govt. College of Commerce and Economics, Karachi I, Pakistan.
Badran, Abdel Rahman, 73, Cromwell Rd., London, S.W.7.
Burrell, William Henry, Oxford Regional Hospital Board, Regional Records Unit, 17, Parks Rd., Oxford.
Bushell, Frank Dudley, Westminster Hospital, St. John's Gdns., London, S.W.1.
Caffin, Sidney William, Commonwealth Actuary's Office, Barton, Canberra, Australia.
Calpine, Hilton Cecil, Pound Cottage, Chiddingfold, Godalming, Surrey.
Chown, Leslie Newton, Balliol College, Oxford.
Clark, Kenneth Owen, Matatoki, Thames, New Zealand.
Codd, Robert Brinley, Treasurer's Division, Welsh Regional Hospital Board, Temple of Peace and Health, Cathays Park, Cardiff.
Cox, Charles Philip, National Institute for Research in Dairying, Shinfield, nr. Reading, Berks.
Crawford, Kenneth Gault, 27, Lowther Hill, London, S.E.23.
Crystal, Alexander, Market Information Services Ltd., 1, Old Burlington St., London, W.1.
Curnow, Raymond Charles, 48, Westbourne Park Villas, London, W.2.
Davies, Percival, Moorlinch, 11, St. Alban Avenue, Gabalfa, Cardiff.
Duckworth, Jack Burnett, Victoria Hospital, Blackpool.
Duff, John Thomas, Ministry of Transport, Berkeley Square House, London, W.1.
Durbin, James, London School of Economics, W.C.2.
Edge, John, Mathematics Dept., Imperial College of Science and Technology, London, S.W.7.
Eisenklam, Paul, Chemical Engineering Dept., Imperial College of Science and Technology, London, S.W.7.
Ellison, Thomas Richardson, 3, de la Pole Cottages, Willerby, Hull, Yorks.
Fakley, Dennis Charles, Sadlers, Grayswood Road, Haslemere, Surrey.
Gale, George Ivan, Grant Advertising Ltd., 36, Grosvenor St., London, W.1.
Gander, Royston Sandford, 6, Newton Terrace, Leeds, 7.
Garvie, Andrew, Woodlands House, Halifax, Yorks.
Gayen, Anil Kumar, 17, Sardar Sankar Rd., P.O. Rashbehari Avenue, Calcutta, 29, India.
George, Frank Honywill, University of Bristol, Bristol, 8.
Geoghegan, Basil, Dept. of Human Anatomy, The University Museum, Oxford.
Gilder, Frank Edwin, The United Africa Co. Ltd., Unilever House, London, E.C.4.
Good, Isidore Jacob, 131, Cheviot Gdns., London, N.W.2.
Graham, Harold Thomas, 18, Drayson Mews, Holland St., London, W.8.
Gupta, Krishna Swaroopa, Post Box 1174, Delhi, India.
Guy, Charles John, 75, Castle Rd., Bedford.
Gye, Richard, 406, Hurst Rd., West Molesey, Surrey.
Hall, Leslie Lister, 81, Cheadle Old Rd., Edgeley, Stockport, Cheshire.
Harris, James Tegwyn, Swansea University College, Singleton Park, Swansea.
Harvey, Rex Anthony, Messrs. Vickers-Armstrongs Ltd., Supermarine Works, Winchester.
Henderson, Kenneth Victor, Foreign Service of the U.S.A., Office of the Commercial Attaché, 1, Grosvenor Square, London, W.1.
Higgins, Stanley Noel, Army Operational Research Group, Broadoaks, West Byfleet, Surrey.
Hill-Smith, Derek Edward, Municipal & General Societies Ltd., 9, Cloak Lane, Cannon St., London, E.C.4.
Hughes, Cyril Davenport, Economic Survey and Central Statistics Dept., Renold & Coventry Chain Co. Ltd., Manchester.
Hughes, Thomas Ffowc, 84, Brondesbury Villas, London, N.W.6.
Jenkins, John Charles, Camden Ridge, Southill Rd., Chislehurst, Kent.
Jonas, Peter Julius, 18, Brookfield Mansions, Highgate West Hill, London, N.6.
Jones, John Islwyn, 8, Boyne Rd., London, S.E.13.
Kar, Jnanendra Mohan, c/o Sgt. N. Basu, No. 4, A.P. Sen Rd., Lucknow, India.
Keeney, Roger Deyo, Metropolitan Life Insurance Co., 1, Madison Avenue, New York, 10, N.Y., U.S.A.
Khan, Abdul Qayyum, 77, Bridge Lane, London, N.W.11.
Leak, William Harold, 1, Loftin Way, Beehive Lane, Chelmsford, Essex.
Lewis, Tobias, 13, Talbot House, 98, St. Martin's Lane, London, W.C.2.
McKelvie, Alaster Ian, 94, Old Tiverton Rd., Exeter.
Mackenzie, Hugh Cormack, Reconstruction Research Group, 21, Berkeley Sq., Bristol, 8.
Manolescue, John W., The Apollinaris Co. Ltd., Stratford Place, London, W.1.
Marriott, Arthur Leonard, National Union of Agricultural Workers, 308, Grays Inn Rd., London, W.C.1.
Naylor, Geoffrey Charles, 60, Salisbury Rd., Carshalton, Surrey.
Nelson, Philip Henry, Messrs. Stewarts & Lloyds Ltd., Iron, Steel and Tube Works, Corby, Northants.
Nicholson, Robert John, Dept. of Economics and Commerce, University College, Hull.
Pantry, Glaister Constantine, 1A, Sarah St., Allman Town P.O., Kingston, Jamaica, B.W.I.
Perfect, Peter Richard, 160, Regent's Park Rd., London, N.3.
Petersen, George Gabriel, 218, Westrow Drive, Barking, Essex.
Pittam, Lawrence Arthur, 55, Parkfield Avenue, Delapre, Northampton.
Quartey, James, Rothamsted Experimental Station, Harpenden, Herts.
Rao, Bhagavathula Venkata Shesha Chalapathi, Bombay Airport, Santa Cruz East, Bombay, 25, India.
Rees, Howard, University College, Singleton Park, Swansea.
Robertson, Donald Graham, 37, Fountainhall Rd., Edinburgh, 9.
Ross, Alexander Burt, Modderfontain Dynamite Factory, P.O. Northrand, Transvaal, S. Africa.
Saxena, Deoki Nandan, Post-Graduate Dept., London School of Economics, W.C.2.
Seers, Dudley George, c/o Institute of Statistics, 91, Banbury Rd., Oxford.

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Smith, Robert Thomson, Messrs. Pommer & Thomsen Ltd., South Denes Rd., Great Yarmouth.
Smith, William Arthur Leslie, Booker Bros., McConnell & Co. Ltd., 37/41, Gracechurch St., London, E.C.3.
Spendley, William, I.C.I. Ltd., Billingham Division, Billingham, Co. Durham.
Stephenson, John Alfred, 2, Queen's Parade, Cheltenham, Glos.
Stewart, James Leslie, 4, Haldon Rd., London, S.W.18.
Sutton, Leslie Stanton, 7, Denver Rd., Queensway, Rochdale, Lancs.
Tout, Alan Frederick, Bowater's Development & Research Ltd., Central Research Laboratories, Northfleet, Kent.
Townsend, Charles Henry, Wholesale Textile Association, 75, Cannon St., London, E.C.4.
Tukey, John Wilder, Fine Hall, Box 708, Princeton, N.J., U.S.A.
West, Harold Edgoose, 349, Billing Rd. East, Northampton.
White, William Walford, c/o National Provincial Bank Ltd., Romford, Essex.
Williams, John Ridgwell, 16, Sandileigh, Hoole, Cheshire
Williams, Kenneth, Simon-Carves Ltd., Cheadle Heath, Stockport, Cheshire.
Wilson, Andrew Lawrence, 35, Craven St., London, W.C.2.
Wookey, Norman, c/o Group Research Dept., Scribbans-Kemp Ltd., North Circular Rd., London, N.W.2.
Wynn, Arthur Henry Ashford, 6, Edgebrook Rd., Sheffield, 7.

Corporate Representatives

Brierly, Kenneth Leslie, *representing* A. C. Nielson Co. Ltd., 109, St. Aldates, Oxford.
Burkart, Arthur John, *representing* Hulton Press Ltd., 43-44 Shoe Lane, London, E.C.4.
Campbell, Lawrence Eversley, *representing* British Food Manufacturing Industries Research Association, 2, Dalmeny Avenue, London, N.7.

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APPEN

STATEMENT OF INCOME AND EXPENDITURE

EXPENDITURE

1948 £	1948 £		1949 £	1949 £
	380	Rent		380
	341	House expenses		404
	1,733	Salaries and wages (including contribution to staff superannuation scheme)		1,813
	239	Pension and allowance		239
	29	Insurance		20
	36	Office equipment		45
	190	Postage and telephone		113
	672	Stationery and miscellaneous printing		253
		Publication and distribution expenses:		
2,013		Journal, Series A (General) and reprints	2,918	
908		Journal, Series B (Methodological) and reprints	1,472	
	2,921			4,390
		Library:		
85		Books	127	
76		Binding	49	
	161			176
	200	General Meetings—ordinary and annual		145
	34	Council and committee travelling expenses		39
		Expenses of sections:		
52		Research	67	
90		Industrial applications	244	
14		Study	25	
	156			336
		Examination expenses:		
45		Printing, stationery, postage and rent of hall	66	
31		Examiners' fees	77	
	76			143
	37	Auditor's fee (1948)		37
	29	Miscellaneous expenses		52
	7,234			8,585
	572	Balance carried to Accumulated Fund, being excess of income over expenditure for the year		653
	7,806			9,238
	429	Amount carried to Life Composition Fee Fund		236
	£8,235			£9,474

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DIX B

FOR THE YEAR ENDED 31ST DECEMBER, 1949

INCOME

1948 £	1948 £		1949 £	1949 £
		Annual subscriptions:		
4,350		Fellowship	*4,715*	
2		Research Section	1	
96		Industrial Applications Section	86	
2		Study Section...	1	
——	*4,450*		——	4,803
	50	Contribution from Royal Economic Society		50
	578	Dividends and interest (gross)		601
		Sales of Journal:		
2,135		Journal, Series A (General) and reprints	2,707	
471		Journal, Series B (Methodological) and reprints	916	
——	*2,606*		——	3,623
	3	Sales of other publications		2
		Examination receipts:		
92		Fees	142	
11		Sale of papers	15	
——	*103*		——	157
	1	Special donations		—
	15	Miscellaneous receipts		2
	7,806			9,238
	429	Life Composition Fees		236
	£8,235			£9,474

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APPEN

BALANCE SHEET AT

FUNDS AND LIABILITIES

1948 £	1948 £		1949 £	1949 £
		Accumulated Fund:		
6,186		Balance at 31st December, 1948	6,863	
105		*Add:* Amount transferred from Life Composition Fee Fund ...	126	
572		Excess of income over expenditure for the year per annexed account	653	
	6,863			7,642
		Life Composition Fee Fund:		
6,448		Balance at 31st December, 1948	6,772	
429		*Add:* Life Composition Fees received during year	236	
6,877			7,008	
105		*Less:* Contributions of compounders who died during year transferred to Accumulated Fund	126	
	6,772			6,882
		Building Fund (per contra):		
1,192		Balance at 31st December, 1948	1,237	
45		*Add:* Income for year	46	
	1,237			1,283
		Liabilities and Income held in suspense:		
2,023		Sundry Creditors	2,204	
		Amounts received in advance:		
225		Annual subscriptions	303	
1,155		Payments for Journals	1,058	
68		Examination fees...	28	
	3,471			3,59
	18,343			19,400
		Frances Wood Memorial Fund (per contra):		
512		Balance at 31st December, 1948	542	
30		*Add:* Income for year	21	
542			563	
—		*Less: Prizes awarded in* 1949	60	
	542			503
	£18,885			£19,903

HEYWORTH, *President.*

J. H. JONES, *Honorary Treasurer.*

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DIX C

31ST DECEMBER, 1949

ASSETS

1948 £	£		1949 £	£
		Investments at cost or under:		
5,580		£10,527 12*s.* 3*d.* 2½% Consols (Guy Bequest)	5,580	
1,185		£2,236 11*s.* 3*d.* 2½% Consols	1,185	
1,324		£1,864 14*s.* 1*d.* 3½% Conversion Loan	1,324	
490		£500 3½% War Loan	490	
—		£1,486 13*s.* 10*d.* 3% Savings Bonds 1955–65	1,486	
2,992		£2,970 1*s.* 10*d.* 3% Savings Bonds 1965–75	2,992	
2,000		£2,000 3% Defence Bonds	2,000	
100		£194 16*s.* 1*d.* 3% British Transport Guaranteed Stock 1978–88	100	
13,671			15,157	
		(Market Value, *less* interest accrued, 31/12/49 £17,534, 31/12/48 £17,893.)		
		Investment (Building Fund):		
1,237		£1,350 18*s.* 8*d.* 3½% Conversion Loan	1,283	
		(Market Value, 31/12/49 £1,270, 31/12/48 £1,390.)		
	14,908			16,440
		Current Assets:		
600		Debtors and amounts paid in advance	512	
84		Arrears of subscriptions recoverable (estimated)	84	
155		Interest accrued on investments (gross)	172	
2,596		Cash at banks and in hand	2,192	
	3,435			2,960
	18,343			19,400
		Frances Wood Memorial Fund:		
300		£512 12*s.* 6*d.* 3% British Transport Guaranteed Stock 1978–88	300	
		(Market Value, 31/12/49 £461, 31/12/48 £515.)		
228		Post Office Savings Bank Deposit	199	
14		Income tax refund due	4	
	542			503
	£18,885			£19,903

NOTE.—No value is placed in the Accounts on—
(1) Journals and other publications in stock.
(2) Books in library.
(3) Pictures, furniture and equipment.

REPORT OF THE AUDITOR

I have obtained all the information and explanations which to the best of my knowledge and belief were necessary for the purposes of my audit. In my opinion proper books of account have been kept by the Society so far as appears from my examination of those books.

I have examined the above balance sheet and annexed statement of income and expenditure which are in agreement with the books of account. In my opinion and to the best of my information and according to the explanations given me the Balance Sheet gives a true and fair view of the state of the Society's affairs as at 31st December, 1949, and the statement of income and expenditure gives a true and fair view of the Income and Expenditure for the year ended on that date.

5, London Wall Buildings,
E.C.2;
24th May, 1950.

A. RAE SMITH, Auditor,
Chartered Accountant.

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PROCEEDINGS OF THE ONE HUNDRED AND SIXTEENTH ANNUAL GENERAL MEETING OF THE ROYAL STATISTICAL SOCIETY, held at the London School of Hygiene and Tropical Medicine, on Wednesday, June 21st, 1950.

The Chair was taken by the President, Sir Geoffrey Heyworth.

The President presented the Report of the Council for the financial year 1949 and the session 1949–50, and moved that it be adopted.

During his submission of the Report he presented a Guy Medal in silver to Mr. H. Campion, and Certificates to the successful candidates in the 1950 Certificate examination who were able to be present at the meeting.

The Honorary Treasurer, Professor J. H. Jones, presented the accounts and seconded the motion for the adoption of the Report.

On the proposal of Dr. David Heron, seconded by Dr. Wishart, Sir Alan Rae Smith was re-elected Auditor of the Society for the session 1950–51 at a fee of thirty-five guineas.

The President announced that as no alternative nominations had been received, the President, Council, and Officers for the session 1950–51, nominated as shown on the list already circulated, were duly elected.

The Report was unanimously adopted.

The meeting then terminated.

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REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

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1.—*Experimental Designs.* By William G. Cochran and Gertrude M. Cox. New York: John Wiley & Sons, Inc. (London: Chapman and Hall, Ltd.), 1950. ix + 454 pp. 9″. $5.75.

It was once said of Fisher's *Design of Experiments* that it was not a book which a beginner ought to read unless he had read it before. This was a tribute to the originality of the work, a comment on Fisher's condensed way of stating his results and a plea for a more extensive account of the subject. In view of the interest in experimental design throughout the scientific world, there has been a striking lack of textbooks about it. There are chapters in general textbooks, some rather specialized bulletins, and a scattered literature in scientific journals; but no comprehensive development within the covers of a single book.

Fortunately, it is one of the features of the Rothamsted strain of statistician that it flourishes on a variety of soils. Professor Fisher himself has been transplanted twice with no diminution of vigour or fertility. Professor Cochran, a member of what may perhaps be called the F_1 generation, and Miss Cox, who, I suppose, belongs to F_2 (Professor Snedecor being the intermediate F_1), are in the direct line of descent. Their work at Iowa, and later in North Carolina, in carrying out experimental designs, in advising their colleagues and in teaching the subject to students has given them exemplary qualifications for writing a book on experimental design. Those of us who knew that the work was in contemplation have been looking forward to its appearance with keen interest, and an anxious hope that their preoccupations in other fields would not prevent them from finishing it.

One opens this book, therefore, with high expectations; and let me say at once that they are not disappointed. By way of overture there are two lively introductory chapters on fundamentals with some admirable practical illustrations, and a chapter on the statistical analysis of experimental results. The remainder of the book, twelve chapters in all, deals in detail with the principles of randomization, factorial designs, balanced and partially balanced blocks, confounding and the various kinds of layout to which they lead. Altogether about 150 designs are described, analysed and discussed. Great pains have been taken in the exemplification.

Under the title of Experimental Design it would be possible to write at least three books, none of which bore any resemblance to the others: (*a*) the Philosophical, dealing with the general problem of scientific induction; (*b*) the Mathematical, expounding the systematics of experimental

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arrangement in terms of Abelian groups and Galois fields; (*c*) the Statistical, dealing *inter alia* with the theory of tests of hypotheses and significance in probability distributions. Cochran and Cox do not fall into any of these categories. Their treatment of fundamentals is based on broad considerations of common sense; they have little to say about the methods of constructing or enumerating complete sets of designs of given type; and their chapter on statistical analysis is very condensed, being a kind of summary of what the reader is supposed to know already. To count these as omissions, however, would be to misunderstand the authors' object, which is to provide the experimenter with a handbook showing what resources are available to him and how to use them—for example, the authors treat only of designs which have proved their value in experimental work. There has been a growing need for such a book, and it is a most welcome addition to statistical literature.

M. G. K.

2.—*A First Course in Probability and Statistics.* By J. Neyman. New York: Henry Holt, 1950. ix + 350 pp. 9″. $3.50.

This book is intended as an introductory course in probability and statistics for students who are encountering the subject for the first time and have little mathematics beyond elementary algebra. Its contents are very different from other books of such type. The first chapter is intended to introduce the readers to the concept of statistics as a theory which provides rules of inductive behaviour. To illustrate this, an extensive discussion is made of a probability problem originally proposed by the Chevalier de Méré. The ideas of statistical decision functions, sets of admissible hypotheses, and performance characteristics are illustrated in terms of this problem. This chapter is fairly stiff going for a beginner.

Chapter 2 deals with the theory of probability, which is given a definition of classical type in terms of a finite "fundamental probability set". Only a finite set of possible events is considered and the book nowhere deals with variates which can take an infinite or continuous set of values. The elementary rules of probability are illustrated by some interesting examples. Next follows an exposition of elementary formulae for permutations and combinations (which have already been used), but the author seems to make very heavy weather out of this. For example, two-and-one-half pages are taken up by a proof of the formula for the number of permutations of n things k at a time, and a four-page proof is given of the binomial theorem for an integral index which can only be described as a real masterpiece of obscurity. Next follows a 20-page exposition of an elaborate problem of risk which is very interesting in itself but quite unsuitable to an introductory text-book. Chapter 3 (68 pages) is a discussion of the probability problems of genetics in so far as they can be treated at this level. This contains a large amount of material which anyone interested in the classical theory of probability will enjoy but which seems something of an intrusion at this point.

The next chapter deals with random variables but is confined to those which can take a finite set of values only. The binomial and hypergeometric distributions are discussed and something said about their convergence to the Poisson and normal but the latter are not considered in detail in themselves because they involve infinite sets. A long proof is given of the asymptotic representation of the binomial distribution by the normal distribution function. It is remarkable that neither in this chapter nor anywhere else in the book are the mean and standard deviation of a distribution mentioned.

The last and most important chapter is devoted to the theory of statistical tests. This is illustrated by a long discussion of Fisher's classical example of an experiment to determine whether a lady tasting tea can decide whether the tea or the milk was put in the cup first. No statistician can fail to benefit by a careful study of this section. This chapter also contains a discussion of the lambda principle of constructing tests, industrial sampling, and capture-recapture sampling methods.

Scattered through this book there are a large number of well constructed examples. Whilst by an acknowledged expert and containing much which teachers of statistics will find valuable and interesting, this book cannot be recommended as an introduction to the subject, and the average student will find it bewildering. Although not marked volume I, it would appear from scattered remarks in the text that a sequel is intended. If this is so, statisticians will rightly look forward to it. The present volume is admirably printed and the proof-reading excellent.

P. A. M.

3.—*An Introduction to the Theory of Statistics.* By G. Udny Yule and M. G. Kendall. London: Griffin, 1950. 14th ed. xxiv + 701 pp. 9″. 34*s*.

"Yule and Kendall" is so old a friend that it has been easy to forget its faults. But so much has happened in the statistical world since the last major revision, in 1937, that Professor Kendall

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(in consultation with Mr. Yule) has undoubtedly been wise to rejuvenate the book. In its new form it will certainly remain a standard textbook for another generation of statisticians.

Chapters 1 to 5 of the last edition, on the theory of attributes, have been condensed into three chapters. As far as this reviewer is concerned, this means that the rubric "Omit chapters 1 to 5" will now read "Omit chapters 1 to 3." It is, of course, perfectly logical to start with the theory of attributes, as being conceptually simpler than the theory of frequency distributions which follows it. But this is a textbook, and what is a logical order is not always the right order for teaching or learning. It seems a little hard to arrive at Tschuprow's coefficient of contingency on p. 54, and the arithmetic mean only on p. 104.

One feels, too, that a little more attention might be paid to the Sherlock Holmes principle, that one should not pack one's mental attic with useless information. 700 pages is rather a formidable course, and it might have been useful to ask a number of working statisticians which of the subjects mentioned had ever been of use to them in their work. The page devoted to Gini's Mean Difference would probably score low marks by this test; and even enthusiasm for the semi-interquartile range exists mainly in the minds of examiners. Any intelligent student should be able to look up the uses of the rarer tools in a book of reference, if he ever needs them. The teaching of statistics, more than that of almost any other subject, suffers from the inability of students to see the wood for the trees, and it is a pity to obstruct the view with useless lumber.

One of the most valuable features of Yule and Kendall is the use of introductory chapters, such as chapters 4, 9 and 16, which survey, with an abundance of illustration, the basic ideas of a subject. These are, as they always have been, first-rate; they give the reader a sense of the "shape" of the material with which he has to deal, and a broad picture of the statistical problems which confront him. One wonders, in fact, whether a statistical text-book ought not ideally to be divided into two volumes, "ideas" and "tools," so as to give the student a chance of seeing the subject in the round before he becomes immersed in details such as the determinant ω (p. 289). The volume on "ideas" would then be available to help that large class of non-mathematicians who in fact prepare and handle the great majority of the statistical material in daily use. Yule and Kendall is much too frightening for the man who left his mathematics behind at 16; and indeed it is not quite clear what class of mathematical knowledge it is intended to assume. Several results are stated without proof, and the methods used are elementary; but the illusion dies hard, with those of us who have had any mathematical training, that a book using elementary methods is itself elementary. In nine cases out of ten it is not lack of knowledge of mathematical tools, but lack of the habit of mathematical thinking, which makes a book seem difficult. I suspect that a man who can ride victorious through Yule and Kendall's 700 pages will in fact know more mathematical tools than they give him credit for; while a man fulfilling the conditions laid down in the preface to the first edition, "an acquaintance with algebra up to the binomial theorem, together with such elements of co-ordinate geometry as are now generally included therewith", will usually fall by the wayside.

The latter part of the book contains a fair amount of fresh material. There is an introduction to the practical problems of sampling, admirably done, and the economist will be glad to see the arrival of a chapter on index numbers and two on time series. The index number chapter, however, deserves only a qualified welcome; it consists mostly of the things which have always been said about index numbers, ever since Irving Fisher introduced an appearance of orderly theory into the subject; but they are in reality of very secondary importance. Many students know all about the factor reversal test, but are quite incapable of producing a good index number. It is a pity that Professor Kendall did not follow the technique of other introductory chapters in the book, of assembling a series of examples and discussing them.

This technique is in fact followed in the first of the two chapters on time series; there is then a brief discussion of moving averages (but surely Spencer's 21-point formula is too rare in general statistical work to be worth its space?), of variate differences, of serial correlation and the correlogram, and of the periodogram. We are all bunglers when it comes to dealing with time series, and this is our usual bag of crude tools; but one would welcome an even clearer indication, illustrated by examples, of the situations to which each tool is appropriate. There should surely be closer links between the chapters on time series and the discussion in chapter 13 of some of the problems which arise in correlating time series.

One odd casualty of the new edition is the list of references, which has been omitted because an extensive bibliography has appeared in vol. 2 of Kendall's *Advanced Theory of Statistics*. But that bibliography, containing as it does about 1,800 references arranged alphabetically by authors' names, is an impressive testimony to Professor Kendall's industry as a card-indexer, but is entirely useless to the elementary student. He wants to have two or three references which are best suited to carry him one step further on the subject of a given chapter; an excessively long bibliography (such as was carried in earlier editions of Yule and Kendall) is as bad as none at all. It is a great pity that room could not be found for a few references for each chapter.

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A review of a text-book is apt to become an outline of the book which the reviewer is too lazy to write, and thus to become a collection of divergences from the author's point of view. My criticisms must not be allowed to lessen the whole-hearted welcome due to the new appearance of a classic, which in its successive revisions may well live for many decades to come.

C. F. C.

4.—*Chance and Choice by Cardpack and Chessboard.* Vol. I. By Lancelot Hogben. London: Max Parrish, 1950. 417 pp. 10″. 50*s*.

Professor Hogben states in his Foreword that ". . . less than 1 per cent. of research workers clearly apprehend the rationale of statistical techniques they commonly invoke . . .", and he therefore hopes ". . . that an attempt to present the elements of statistical theory by exploiting a new educational technique will commend itself to the sympathetic consideration of statisticians who are also interested in education".

This volume, he continues, avoids ". . . issues of rigour which the author is not competent to arbitrate upon . . ." and ". . . deals only with statistical methods for which it can offer the reader a rationale *en rapport* with the rules of algebra and differential calculus nowadays included in the higher school leaving syllabus, if supplemented by a few less accessible theorems set forth in the introductory chapter".

The book is sub-titled *An Introduction to Probability in Practice by Visual Aids*, and is illustrated by 84 Figures, many of which detail, by suitable combinations of hearts, clubs, diamonds and spades, all the possibilities which occur when sampling a binomial or multinomial population. Others use red and black balls or dice. This set of figures must represent the "new educational technique", as the remainder consist largely of histograms. All are excellently drawn by Miss Gladys Haines from designs by the author, and are obtainable from the publishers as a 2-colour complete set of 84 wall charts. They are likely to prove useful in helping the reader, or a class of students, to realize how the sampling distributions and tests for multinomial populations are derived. One minor criticism of these illustrations is that the accompanying numbers are sometimes (e.g. Fig. 51) almost illegible at ordinary reading distance.

The scope of the book, considered more fully below, is broadly speaking that of Yule and Kendall, introducing the reader to probability and the standard distributions, large sample tests for means and differences between means, confidence interval estimation and correlation. Multinomial distributions predominate throughout, and continuous distributions, such as the normal and Pearson series, are derived as limits from them, so that anyone new to the subject may receive a misleading impression of their importance in practical statistics, considerable though this is. There are plenty of illustrative examples and 354 well-chosen exercises, but no index, which is rather inconvenient in a work of this size. The book can scarcely be recommended for student use, considering its price, but the more mathematically inclined research worker will undoubtedly find much to dispel his ignorance, and a little to increase it.

For the most part the exposition is clear, but there is a tendency to hammer away at a topic for too long (in Chapters 4 and 5 in particular), and confuse the reader without making any real progress, while the mathematics could be abbreviated in several places without leaving the level set by the author in his Foreword, and which he successfully maintains. Those who are acquainted with other statistical texts cannot fail to notice that Professor Hogben uses standard terminology as though he had found the words lying about with no meanings attached to them. Thus *expectation* (p. 101) and *likelihood* (p. 204) are used as though synonymous with frequency; *fiducial limits* (pp. 213–215) are a crude sort of confidence interval; and a test criterion is described (p. 217) as *efficient* when what the author means is powerful. Discrepancies of this kind will not, of course, trouble the beginner—until he decides to extend his reading.

There are also signs that the book has been hastily written: the important concept of mean is first defined (p. 102) in a footnote, and the remarks about convergence are unnecessarily divided between pp. 47 and 236. Finally, it is impossible to review the work without reference to Professor Hogben's style, which, although largely scientific discourse, is characterized at times by the use of artificial expressions. Thus, referring on p. 268 to equation (xv), which reads

$$D_t^x.[G_t(f_x)]_{t=0} = f_x ,$$

he writes, "Having witnessed the process of parturition specified by (*xv*), which delivers the function (f_x) out of the womb of $G_t(f_x)$, let us now examine how we trace the parent of the abandoned offspring, i.e. discover the function which generates f_x". Such devices are not required to further the comprehension of the reader, and indeed this inappropriate play with language diverts his attention from the sense of the text.

In more detail, Chapter I begins with the figurate numbers d_{Fn}, equal to $\binom{n+d-1}{d}$.

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These are followed by the binomial and multinomial theorems for integer and factorial powers, and a section (headed "The Vanishing Triangle") on the forward difference and displacement operators, Gregory-Newton and Maclaurin series. The chapter ends with exponential and logarithmic approximations, including Stirling's formula, the proof of which is deferred to Chapter 6, and the Euler-Maclaurin continuity correction. On pp. 46 and 47 are unexplained statements such as "The assumption is justifiable if the series derived by evaluating the arbitrary constants $A_0, A_1, \ldots A_n$ is uniformly convergent", and "If x is less than unity, this [the series for $ln(1 + x)$] must be convergent". Convergence is defined on p. 236, but uniform convergence makes no further appearance.

If the title has aroused any fears concerning a combinatorial study of chess, these are set at rest in Chapter 2 when the chessboard diagram makes its first entry, illustrating all the possible samples from a finite universe with and without replacement. This leads to the definition (p. 75) of *electivity*: "*the electivity of extracting an* r*-fold sample* [sample size *r*] *of a specified class from one or more universes is the ratio of the number of different ways of extracting such a sample to the number of different ways of extracting all possible* r*-fold sample from the same universe or universes*". It is emphasized that the term has no necessary connection with proportionate frequency in a large number of trials. This is a valuable distinction, and it is therefore to be regretted that the word *chance* occurs in every one of the 23 exercises to Sections 2·05, 2·06 and 2·07. On p. 94 the author provides his link between choice and chance by presupposing "*equipartition of opportunity for association* between individual items". He continues: "Though the principle of equipartition of opportunity for association stated in this form has no necessary connection with the probability of making a correct judgement about the materialization of occurrences, its recognition points the way out of a quagmire of ostensibly empirical, but logically circular, definitions involving statements about events which are *equally likely*". The process for ensuring equipartition of opportunity is called *randomization*, and when the author has given empirical evidence for supposing that a well-shuffled card-pack attains equipartition of opportunity, he apparently considers that the probability problem is solved. As Good remarks on p. 8 of *Probability and the Weighing of Evidence*, "Such experiments have usually given good results, but they cannot *prove* anything". The chapter concludes with what the Foreword calls "Fisher's illuminating tea-cup parable".

Chapter 3 opens by testing the hypothesis that the mean of a binomial population has some fixed value. Means and variances of the binomial and hypergeometric distributions are derived, also the normal as a limit distribution. The Poisson limit of the binomial appears and the theorems of Bernoulli and Tchebycheff are proved. On p. 122 the term "definite integral" is misused, and it is unnecessary to use Stirling's theorem to obtain the Poisson limit. The discussion is more mathematical than anything so far.

The idea of a significance test is extended in Chapter 4 to the difference between the parameter of two binomial populations. The separate estimates p_a and p_b and the pooled estimate p_{ab} give a total of four tests based on binomial tail areas but two of these are cut out when the author decides (p. 147) that the pooled estimate p_{ab} is "less liable to mislead". A normal approximation is introduced, and it is stated (p. 150) that one significant result in the two remaining tests is sufficient. The author then laboriously investigates the distribution of the difference between separate estimates, and eventually reaches, on p. 187, the "critical ratio"

$$(p_a - p_b)\sqrt{ab/p_{ab}q_{ab}(a + b)}$$

which is commonly employed in large samples. The section on p. 192 is headed "Unbiassed Estimate of the Critical Ratio" when actually the unbiassed estimate of binomial variance is given. Judicious pruning would improve this confusing chapter.

Chapter 5 begins with a careful discussion of Bayes' theorem (called on p. 206 an "eighteenth century museum piece"). If p_0 is the estimate of the proportion p from a sample of r, fiducial limits are obtained by assuming $(p_0 - p)\sqrt{r/p_0q_0}$ is normally distributed, and confidence limits by assuming $(p_0 - p)\sqrt{r/pq}$ is normal. After this novel distinction, the author returns to the critical ratio test of p. 187 for the difference between two proportions, and inserts in the denominator the 95 per cent. confidence limits for the overall proportion, getting ratios of 4·9 and 6·0 in the example chosen. He concludes (p. 214), "We may thus derive with 95 per cent. expectation a figure over 4·8 for the critical ratio of the observed difference in conformity with the null hypothesis, a finding which makes the likelihood of the event extremely small". Infinite critical ratios are presumably attained with certainty. Wishing to know how much improvement results from the substitution of one treatment for another, he says (p. 217), "At a given confidence level we may say that our estimate p_a of proportionate success with one treatment (A) does not *exceed* a limit l_a, and that our higher estimate p_b w.r.t. the alternative treatment (B) does not *fall short* of l_b. Thus we can assign a precise measure of confidence to the assertion that treatment B is

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$100(l_b - l_a)$ per cent. more efficacious than treatment A". Unfortunately for the reader, no example of this technique is given.

Next come two tables of approximate sample size necessary for a significant difference between proportions; the baffling heading of the second should probably be altered to read "Minimum number of Cases requisite to confer Significance at the 2σ level", as all its entries are 4/9 of those in the first table, which refers to the 3σ level. This chapter, whose central sections need thorough revision, ends by comparing the normal and Poisson approximations to the binomial.

At this stage the author recovers his customary clarity, although his argument can never be described as concise, and the remainder of the book is unexceptionable. Chapter 6, entirely mathematical, gives an account of moments, moment generating functions, integration, the Wallis product for π leading to Glaisher's proof of Stirling's formula, gamma and beta functions, and the Pearson system of distributions. In Chapter 7 an approach to continuous variation is made by illustrating diagrammatically the distribution of the mean in samples from various discrete populations. This gives an empirical basis for the normal limit, and leads to a normal approximation for the difference distribution, with some discussion of its limitations and a mention of the small-sample test. It is unnecessarily assumed on p. 306 that two large samples come from populations with equal variance. The next two chapters deal with Spearman rank and product-moment correlation coefficients, the correlation-ratio, regression and partial correlation, and in the last chapter, 10, analyses of variance are given for Poisson and Lexis sampling, and for two-way lay-outs. On p. 354 it is better in general to compute $(\Sigma A)(\Sigma B)/n$ rather than $n\,M_a M_b$. The book ends somewhat abruptly after stating the variance-ratio test. R. L. P.

5.—*The Science of Chance*. By H. C. Levinson. New York: Rinehart and Co., 1950. vii + 348 pp. 8″. $2.

"It is not possible to be a professional statistician, in the proper sense of the word, without a good deal of competence in mathematics. It is not necessary, however, to be a professional statistician in order to know the difference between good and bad statistics, or to use soundly the methods that have been developed. To prove the truth of this statement is a major aim of this book." This quotation from an early chapter of *The Science of Chance* would, one imagines, apply to most elementary books on the subject. Dr. Levinson's method, however, is rather individual. It consists in introducing statistical concepts by means of simple probability problems arising in games of chance, a method which has a certain amount of historical justification and considerable entertainment value. He considers in turn roulette, poker, lotteries, craps, contract bridge and speculation in stocks. These chapters form an excellent introduction to the mathematics of gambling. If anyone doubts that the only way to have a reasonable long-term chance of success at Monte Carlo is to own the bank, he should read the early chapters of this book. British readers will welcome the exposition of the rules of craps, but they are expected to be familiar with those of poker. Incidentally, the gambler who is wondering whether to practise his art in the United States should note that the crapshooter loses in the long run 1·41 per cent. of his stake, as compared with 1·35 per cent. on the even chances at Monte Carlo roulette.

The section on statistics which occupies the second half of the book includes chapters on the application of statistical methods to advertising and business (by which is meant problems of costing and sales policy rather than production). The whole book is written with a minimum of algebra, and a good deal of common sense.

The detail in which the early chapters are presented is, unfortunately, rather out of proportion to the scanty treatment given later to basic statistical concepts. For example, tables are presented and discussed, giving the probabilities of improving an original poker hand in various ways, or probabilities of various distributions of suit lengths in a bridge hand; in the later chapters, on the other hand, the only significance test explained at all adequately is that for the discrepancy between observed and expected proportions, using the standard error. This lack of proportion detracts from the book's value as an introduction to statistics, although it may be recommended for supplementary reading.

It is surprising that in preparing *The Science of Chance*, which is a revision and expansion of an earlier publication, *Your Chance to Win*, the author did not abandon the probable error, which is now almost obsolete. Certain passages in the second half of the book are open to more serious criticism. There is, in particular, an example of unorthodox statistical inference on p. 306; a comparison of the responses to a new method of advertising with the known distribution of responses to the old method reveals a difference which would be exceeded with a chance of 1 in 5·65 if the two methods were equally effective, from which it is concluded that the probability that the new method is better than the old is 4·65/5·65. The reader should also note that on p. 241 the "Poisson distribution" is not the usual distribution of that name, but the Poissonian form of the binomial distribution. P. A.

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6.—*Les méthodes statistiques dans l'expérimentation biologique.* By Ph. L'Héritier. Paris: Centre National de la Recherche Scientifique, 1949. 95 pp. 9″. 400 francs.

This short book sets out the basic methods of statistical science for French readers. Successive chapters are concerned with laws of distribution, means and percentages, tests of homogeneity and conformity with hypotheses, regression and correlation, analysis of variance, and the design and analysis of experiments. The book is similar in character to Fisher's *Statistical Methods for Research Workers*, though it is more elementary in content and makes no claim to originality. The chief difference from English introductory texts for biologists appears to be a greater willingness to present mathematical arguments. The criteria for the standard tests of significance are shown graphically, instead of by tables—a change from the usual practice which has little to recommend it.

Within its limited compass this book should prove of value to French-speaking biologists, for it provides a clear and reliable exposition of the more important analytical methods, and illustrates these by discussion of data from the author's personal experience. For the English reader it has no features of special interest. D. J. F.

7.—*Le Calcul des Probabilités et ses Applications.* (Colloques Internationaux du Centre National de la Recherche Scientifique, xiii.) Paris: C.N.R.S. (London: H. K. Lewis), 1949. 130 pp. 10½″. 35*s*.

This volume contains sixteen papers on the theory of probability which were read at an international conference held at Lyons in June and July, 1948. Most of them are more concerned with the theory of probability than with its applications but their importance and interest are considerable.

Ottaviani has a paper on the foundations of the theory of probability which is concerned with the relation between the law of large numbers and the probability theory of Mises. Darmois has a paper on the dependence between random variables. Let $A(x)$ and $B(x)$ be the cumulative distribution functions of the random variables x and y, and $F(x, y)$ their joint cumulative distribution. Darmois then shows by an example that it is possible to have distributions for which $F - AB$ can take both positive and negative values and considers some further problems of a similar kind. Doob has a paper on what is known as the theory of "martingales". A martingale is a system of random variable (X_n) which all possess finite first moments and are such that the conditional expectation of X_n given X_{n-1}, X_{n-2}, . . . is X_{n-1}. This unpromising looking object has a number of interesting properties previously established by Doob which he now applies to two problems—Kolmogoroff's version of the strong law of large numbers, and a problem in estimation theory.

Van Dantzig studies problems concerned with discrete sets of possibly dependent events by introducing a wide generalization of the theory of generating functions. He extends results recently given in a tract of Fréchet, and the method appears to have promising possibilities. Fréchet gives some new results in his theory of "typical values" of random variables, and Lévy considers "double Markoff processes", i.e. random functions of two continuous variables, which are such that if L is a line separating the plane of the two variables into two regions, R_1 and R_2, the conditional distribution of the random variable at a point in R_1 (say), given the values on L, is independent of the values in R_2. Lévy considers a number of examples and some general theorems which tend to show that all such processes are in some sense degenerate.

Blanc-Lapiere has a paper on the spectral analysis of stationary random processes from the point of view of their application to electrical filter theory, and this is followed by a paper by Kampé de Fériet which generalizes the idea of a random function of time to a random function on an abstract space subject to a group of transformations, thus enabling one to apply the idea of stationarity. Wold discusses the idea of "point processes". These are processes in which, instead of having random variables defined for varying time, one has a series of events occurring at random on the time axis and showing some form of stochastic dependence. Such processes have been considered before (e.g. the emission of particles from radio-active substances), but Wold gives an interesting systematic discussion.

Halphen makes some general remarks on the logic of the theory of estimation, and Wishart discusses tests of significance in the analysis of variance and covariance. Delaporte has a paper considering distributions connected with factorial analysis in psychology, but does not discuss the objections which have been brought against this type of theory. Fortet considers the classical problem of the loss of a telephone call under conditions which, although unrealistic in a telephone exchange, is of relevance to the theory of Geiger-Muller counters. Ville has an expository article on the statistical theory of the transmission of information, a subject which has been recently investigated by a number of British and American writers. Finally there is a paper by Málecot

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on stochastic processes occurring in the genetical theory of population, and one by Eyraud on mathematical economics.

This book contains many important contributions, and should be read by every mathematical statistician. P. A. M.

8.—*Complementi di Calcolo delle Probabilità*. By Professor Giuseppe Pompilj. Rome: Eredi Virgilio Veschi, Anno Accademico 1948–9. iv + 276 [8], pp. 9½″.

This text-book on probability is somewhat unusual among continental works in that the influence of statistical applications is apparent both in the general structure and in the detail of the book. There is not, indeed, any thorough formal development of statistical method, but there are many analyses of numerical data to exemplify particular theoretical results.

It is assumed that the reader already possesses an elementary knowledge of probability theory—the author suggests Castelnuovo's *Calcolo delle Probabilità* as appropriate prior reading. The first section of the book deals with various kinds of distributions, and their description by means of an unusually varied assortment of moments and indices of correlation. The second section deals with various schemes of repeated trials. The third section is entitled "Sampling Theory", but is in fact restricted to the consideration of expected values of the various kinds of sample moments referred to in the first section. Problems of inverse probability are discussed in the brief fourth section.

The fifth and final section, entitled "Theory of Conformity", deals directly with applications of probability to statistical inference. Following a rather inadequate discussion of systems of statistical inference in present use, the author comes to the conclusion that statistical tests are to be regarded as tests of "conformity" with some theoretical model, and that the term "significance" is a misnomer. The well-known fallacy is propounded that of a number of tests the one least favourable to the hypothesis tested is to be preferred. As a special case of this doctrine it is laid down that if the observed value of a criterion T be T_0, then the appropriate measure of conformity is the lesser of $Pr.\{T \geqslant T_0\}$ and $Pr.\{T \leqslant T_0\}$. However, the systematic treatment of analysis of variance theory is developed quite competently, and is the best feature of this section.

While its development of probability theory *per se* makes this book of interest as exemplifying the approach of the Italian school, the treatment of statistical theory in the final section is both unsatisfactory and misleading. Further, the book is a photographic reproduction of *manuscript*, and is rather troublesome to read. Adding to this the language difficulty and the fact that there is little material not available in English texts, the reviewer feels that the book would prove unrewarding to most English readers. N. L. J.

9.—*Nomography*. By Alexander S. Levens. New York: John Wiley. (London: Chapman & Hall.) 1948. vii + 176 pp. 9″. 24*s*.

This book is an elementary treatise of the fundamentals of nomography most effectively illustrated by practical examples from industry, but it does not deal with the more advanced aspects of the subject. Although elementary cartesian representations are offered in the Introduction, emphasis is mainly placed on the alignment chart, both in the form of parallel lines as well as in the Z form (parallel lines intersected by a slanted line). To these is added the "proportional chart" (in which 4 scales are marked off on the 4 sides of a rectangle and two alignments are made to intersect on one of the diagonals). The use of curved scales is also discussed in miscellaneous examples, but the tendency appears to be to avoid these and their treatment is somewhat cursory.

Effective combination of these elementary charts further widens the scope of their applicability, but the arrangement of charts in consecutive quadrants is not stressed sufficiently. On pp. 116–21 a useful summary of the treated functional equations is given, and the Appendix contains 29 further interesting examples of charts mainly for engineering problems. In particular Figs. 27A and 28A give alignment charts for the computation of standard deviation and correlation coefficient from the sums of squares and products and the sample size. H. O. H.

10.—*Human Ability: A Continuation of the Abilities of Man*. By Professor C. Spearman and Dr. Ll. Wynn Jones. London: Macmillan, 1950. vii + 198 pp. 8½″. 16*s*.

Dr. Wynn Jones opens his preface with the words, "This volume was planned by Professor Spearman to be a continuation of the *Abilities of Man*". The circumstances under which it was written and the difficulties which Dr. Wynn Jones must have faced disarm a good deal of criticism: I am sure most readers will not attach undue importance to superficial blemishes. The interest of the book lies in its being an attempt to summarize Spearman's final position: his

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relationship to the whole factor movement is so fundamental that his last views are at least of strong historical interest.

For many statisticians factor methods are an acquired taste, or even an aversion. Such a book as this, however, could be of interest to them in two ways, either by presenting a critical review of technique, or by an exposition of the way in which factors emerge and how the problem of identification is tackled. Under the first category, the treatment of technique is here far too summary to allow a convincing argument to be developed. It is difficult, for example, to accept the one paragraph which is devoted to matrix algebra as a serious treatment of the topic. In fact, unless a reader is well acquainted with methods of factorization, he will not be much better informed after reading the book. Two chapters stand out as likely to be of interest to statisticians in the second category, Chapter VIII on the interpretation of G and Chapter XI on mechanical factors. In both there is considerable deployment of evidence, and the reader begins to feel that he can follow the story to some extent. Both chapters illustrate the type of effort which one has to make to bridge what is called the "statistical-psychological gap". There is, however, a curiously uncritical strain running through the presentation of evidence which may be illustrated from the chapters dealing with Intelligence, Inertia and Oscillation. In Chapter X on Intelligence, results published in 1904 and 1938 are presented as directly comparable, though it is hard to believe that there were no improvements in technique or development of concept in the meantime. In Chapter XV, on the Law of Inertia, there is no hint that the various pieces of work which are quoted as evidence use methods which have been shown by others, elsewhere, to emphasize different aspects of performance. In Chapter XIX on Oscillation a similar point may be noted, for no distinction is made between workers who deal with periodic fluctuation and others who refer only to variability. Even the work on periodicity in performance is not, in my opinion, homogeneous, the times of peaks and troughs in some work being found to form arithmetic and in other work geometric progressions.

With respect to the central problem of the existence and meaning of "*g*", I hold that the main argument is defective, and give the following quotations in support of this view. Page 20: "So long, however, as we remain within the sphere of pure statistics, the matter appears to be simple enough. We will accept the ordinary usage of words, and will take (*B*) and (*K*) ((*B*) and (*K*) refer to the equations $\frac{r_{ac}}{r_{ad}} = \frac{r_{bc}}{r_{ba}}$ and $G_x = r_{ag} M_{ax}$ respectively—reviewer) to have been proved to exist really when, and only when, the available evidence has shown these equations to be actually and stably satisfied. The case of *G* and *S* is quite analogous. These values, too, will be taken to exist really whenever they have been actually observed or otherwise proved".

Page 52: "For us the question as to the observation of *G* reduces itself to that of the validity of certain hierarchical equations."

Page 72: "*G* is essentially characterized by the combination of noegenesis with abstractness."

Page 191: "Nevertheless the hypothesis of mental energy has been put forward. The *G* would represent the amount of that energy; *p* would represent the inertia, and *O* would represent the facility of recuperation after effortful expenditure."

The four statements form a coherent sequence, but I submit that if Spearman had seriously considered the problem of the kind of existence which could be postulated for *G*, he would have seen that it was the kind of existence which characterizes, say, a mean value rather than the kind of existence which characterizes a man whose height happens to coincide with the mean height of a group of men. It seems clear that the type of hypothesis which can be entertained about *G* or other factors must depend to a considerable extent on the kind of existence which can be predicated of them.

This book also tends to confirm a view put forward by Thomson that Spearman failed to distinguish clearly between the two-factor theorem and the two-factor theory. The former is a theorem about the dimensions of space required to contain a pencil of vectors, as a consequence of relations among the vectors, and is mathematically acceptable; while the latter is a theory about the underlying structure of mental processes and remains highly controversial.

The treatment of the centroid and principal component methods is cavalier, even the latter being regarded as just one more wilful variant. Spearman can never have regarded the axes evolved in the process of factorizing as reference axes only. The force of his main contention seems to have been so strong that, for him, axes which emerge directly have priority over any others. His position is the more rigid because of his insistence that, in order to be meaningful, all loadings must be positive.

Statisticians will find interesting sidelights on Spearman's outlook, and may find a certain naïvete in his statistical views. The short section on "Statistical Policy" yields the following example: to expose the fallacy of Garrett and Anastasi "who have so treated" (i.e. as significant)

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"a well-known correlation coefficient amounting to ·20 with a probable error of ·13 . . .", the authors say "their line of argument is that even a ratio no higher than 3:2 will by mere chance occur only about 'once in six times'. For the alleged ratio of once in six times applies really to two areas of probability which *both* consist of insignificant cases. Whereas the comparison properly required is between cases that are not significant and those which are so".

Finally, I can throw light on a point of disagreement. On p. 22, section (3), under the title "Negative Proof", the authors disagree with an apparently unreasonable requirement by Thomson "when he urges that a special test is needful to prove that any observation is *not* due merely to the error of sampling". This and the quotation which followed seemed most surprising. The quotation from p. 156 of the *Factorial Analysis of Human Ability* is indeed verbally correct, but I found the passage as a whole somewhat obscure. In correspondence, Sir Godfrey Thomson describes the page in question as "very badly put", and says, "All I meant to emphasize is that tests of significance do not prove any hypothesis to be correct, they only show that the odds against the hypothesis are not heavy enough to justify its rejection; usually the odds are nevertheless against any hypothesis and sometimes they are more heavily against it than against some alternative hypothesis". B. B. S.

11.—*The Educational Development of Children.* By W. Glassey and E. J. Weeks. London: University Press, 1950. xiii + 248 pp. $7\frac{1}{4}''$. 8*s.* 6*d.*

The Measurement of Abilities. By P. E. Vernon. London: University Press, 1946. (Reprinted 1949.) xii + 308 pp. $8\frac{1}{2}''$. 15*s.*

Personnel Selection in the British Forces. By P. E. Vernon and J. B. Parry. London: University Press, 1949. 324 pp. $8\frac{1}{2}''$. 20*s.*

These three books all deal with the "objective", "scientific" measurement of psychological qualities in human beings. The technique they recommend is the "sampling" of a subject's behaviour in standard situations, the choice of a set of such situations so that the scores obtained by a given population of subjects will be normally distributed—the score generally being obtained by giving one mark for successful behaviour in a situation, or zero for unsuccessful—and the subsequent correlation of sets of such scores from which, if necessary, traits can be extracted by factor analysis. Between them they cover, like a series of geological strata, the whole history of the mental testing boom, from the first, with its relatively uncritical acceptance of I.Q.'s, to the last, where the value of a test is determined by its validation in the relevant field. Now that excessive claims are no longer made for such tests, it will perhaps be possible to go on to a new stage in the investigation of mental abilities.

The Educational Development of Children is by an inspector and an assistant inspector of schools, and is intended as a guide to teachers in the compiling of scientific records of their pupils. The authors are clearly interested in and well-disposed towards children, and it is probably for this reason that they show a proper amount of common sense in assessing the practical methods they recommend. It is on the theoretical side that they are less happy, particularly where statistics are concerned, and this is most likely due to errors or lack of clarity in the books they themselves have learnt from.

The misconceptions that occur here are, in fact, the ones that psychologists are especially prone to. "Significant" is used almost as if it meant meaningful—there is no suggestion that it stands for "significantly different from" some specified value, and no explanation of the idea of a nul-hypothesis; the normal curve is elevated to a Law of Nature—"when the population examined or tested or assessed is a large one, then according to the 'law of averages' the curve will rise and fall symmetrically about the highest frequency . . . such a curve is called the normal probability curve"; and the probable error is used as a method of setting fiducial limits even for non-normal distributions. These three words, "significant", "normal", and "probable error", form for many testers a mumbo-jumbo trinity that must be accepted, though not understood.

The clinging to probable error, as distinct from standard deviation, the description of Spearman's rank order correlation coefficient as a rough approximation to the product-moment correlation coefficient, and the use of number of groups rather than number of degrees of freedom in the χ^2 table are perhaps more unfashionable than wrong, but serve to show the gulf between current methods among statisticians and those which are still to be found in the more elementary text-books.

The statistical chapters will no doubt be read with most attention by teachers with some knowledge of mathematics, and a certain amount of confusion is in store for these; for instance, the standard score of Table 6 is not the same as that described on the next page; the description of r on page 45 suggests that similar rank order is enough to ensure $r = 1$, although the formula shows

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it will not; and the instructions to pool the small frequency classes in Table 16 are not, in fact, followed. They are also likely to be misled by the suggestion on page 182 that the sum of two normally distributed variates is not normal unless their correlation is high. On the psychological side most of the difficulty arises from the not very clear concept of mental measurement—for instance, the fact that Binet and Simon selected tests "which usually succeeded for a given age" is cited as proof that they were assuming a normal distribution of general mental ability.

The Measurement of Abilities, which was published in 1940 and is now reprinted for the second time, is one of the books to which Glassey and Weeks frequently refer. Its material is of two kinds—a description of how to obtain measures relating to abilities, and some account of the statistical treatment that these measures require. In respect of the latter, we may say that it belongs to the era of text-books on "mechanical" statistics—here is a formula, this is when to use it, "theirs not to reason why". It is generally accurate in its description of methods of calculation, except that the test given for deciding whether percentages are significantly different is not correct and, since it gives results different from the χ^2 test, is very likely to trouble even the uncritical user. We again have probable errors, and no real definition of significance (in fact, on page 96 there is a no doubt unintentional but very unfortunate verbal confusion between significant and reliable). There is a short description of Fisher's z, but the test for significant difference of correlations is still in terms of standard error.

It is when the author discusses measurement, and the validation of measurements, that we feel at sea. As early as page 3 he is committing us to the view that intelligence is a one-dimensional variable, that is, that one can say of any two people either that they are of equal intelligence or that one is more intelligent than the other. When one considers the amount of discussion among statisticians as to whether probabilities form a partially ordered system, one feels that some similar discussion with regard to the important conception of intelligence would not come amiss. This is not to deny that something very useful may not be found to be linear, but the break-up into abilities by statistical methods all depends so much on this basic idea that it really needs a good deal of examination, and merits more than a casual likening to height and weight. This is perhaps the source of certain difficulties that Vernon tries to express, for example on page 87, but it would be better to argue about the fundamental point than to give rules for getting something "objective" and "scientific" and then issue warnings about the results.

The book has the appearance of being written with clarity, but is often, in fact, confusing and rather dull. This is probably because, like so many descriptive text-books, it burkes the real issue, and is content merely to give results. For instance, in dealing with mental age, it says that Mental Age units are reasonably constant from three to ten years, and thereafter become progressively smaller, but gives no hint of how such a result can be established, although an experimental verification is not easy to imagine. The idea of intelligence, as was noted above, is never properly discussed, but pops in and out. Before intelligence is defined in any way, we are instructed to partial it out of a particular ability; later, we are promised a scientific basis for choosing tests with a high g. It appears to be this—if tests which are supposed to measure intelligence are intercorrelated and if the correlations are high, then they do measure the same thing and what they measure is intelligence. This merely means that we, or rather psychologists, are supposed to be able to recognize a test that measures intelligence, though not people who are intelligent (for validation by ranking or rating of subjects is rejected as unreliable). Judgment, which has been put out of the front door, has come in at the back. In fact, all validation of tests must depend in the end on judgment, and statistics is an aid, not a substitute.

The great merit of the third book, *Personnel Selection in the British Forces*, is that it really recognizes this. It might be described as a prolonged exercise in the validation of tests, and that validation is always in the last resort against judgment. When it is actually against judgment in the raw, for instance, ratings of officers in action, it is of course much more interesting than when it is against the remote sort of judgment that scores on passing-out courses constitute. This is altogether a valuable handbook on many forms of personnel selection, and an excellent summary of the value of tests in assigning large numbers of men drawn from every level of the population to suitable tasks. The authors rightly emphasize that such selection procedures are by no means so likely to be successful when applied to smaller, relatively homogeneous groups. The grounds on which statistical techniques are applied are fairly considered, and the difficulties explained. The chief objection that can be made is the reference to the "natural" regression effect (page 185). It should be stressed, firstly, that the regression towards the mean is only certain to occur when the variance of the two variables concerned is the same (as would be roughly true in the case of heights of fathers and sons), because it is only then that the slope of the regression line must be less than 45°; and secondly, that the slope of the regression line is not a proper measure of the relationship of two variables (e.g. first and second scores) unless we can assume that the independent variable is measured without error.

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The impression which remains from all three books is that although the technique of measuring a population against a scale by means of tests which give normally-distributed scores can be of great practical use, especially in dealing with a large and heterogeneous population, it is not the way to get scientific results about individuals; and although in the hands of skilled appliers the somewhat mechanical methods can be of value, they are not the best to put into uncritical hands. In particular, the product-moment correlation coefficient, whose meaning needs so much explaining, and indeed a whole conversion table, and which is so liable to inflation from corrections for attenuation, selectivity and what not, and which can so easily be applied with so little regard for the material, its range, and the linearity of the regression, and which, lastly, can be so readily confused with causal connection—this coefficient seems a particularly dangerous weapon in psychology. It could almost be called the statistical road to the psychological bonfire.

The truth is, that statistical methods particularly adapted to work in psychology have not yet been widely developed, though a beginning has been made by Kendall in his coefficient of rank correlation and measures of consistency of judgment and agreement of judges, all of which are easy both to explain and to use. Let us hope that it will not be too long before these methods have filtered down to the text-book level. The readers of such may well find them more comprehensible as well as of greater value than the ones currently taught. It would be a great pity if teachers were hypnotized by a display of statistical formulae into believing too much in testing methods which, on the whole, have correlations of less than ·4 with subsequent performance.

V. R. C.

12.—*Researches on the Measurement of Human Performance*. By N. H. Mackworth. Medical Research Council (Special Report Series No. 268). London: H.M.S.O., 1950. 156 pp. $9\frac{1}{2}''$. 4*s*.

This report presents and discusses the results of a series of investigations carried out during the war into the performance of men in a few specific operational tasks, but as the discussion proceeds, the general applicability of some of the findings becomes clear; the results of totally different tests of performance showed similar patterns, and it was possible to present in psychological terms a satisfying explanation of the mechanism producing these patterns.

The report is in two halves; the first relates to the performance of men engaged in watch-keeping duties, who are required to detect faint visual or auditory signals when these appear occasionally during a long period—"Vigilance Tests"; the second to the performance of men in abnormal atmospheric conditions, in war gases or at high temperatures—"Environmental Stress Tests". The characteristic circumstances of these operational tasks were carefully formulated, and were reproduced in tests presented to groups of men, either by designing suitable apparatus or by utilizing the operational task itself. The measurement used to classify the performance was the number or proportion of mistakes made, or some similar objective measure, and the tests were so designed as to be roughly of equal difficulty. The experimental subjects were men from the three Services.

The tests enabled a very large number of conclusions to be reached, too many to be detailed here. Most remarkable was the finding that, in the vigilance tests, performance notably declined in the second and subsequent half hours, but could be restored temporarily to normal by a sudden telephone message to the subject in the middle of the test period; yet warning the subject beforehand to be particularly careful during a specified period of the test had no perceptible effect. When the subjects were told how well they were doing as the tests proceeded the decline in performance with time disappeared, and it disappeared also if the subjects were given alternate spells of half an hour on and off duty. The experiments did not allow of detailed examination of the performance during periods of less than half an hour. The tests of the effect of high temperatures showed a falling-off of performance, which became steeper as the temperature increased, and could in fact be well represented by a logarithmic curve. It was shown that the amount of decline depended on the effort put out by the subject, so that for a set task a skilled man was less affected than an unskilled, while in a test of output the skilled man's normal high output was reduced more than the unskilled man's normal lower output. The tests carried out with war gases showed that arsenical smoke by its harassing effect destroyed the incentive to work without seriously affecting physical efficiency, whereas tear gas produced additional loss of performance by causing intermittent loss of vision. The author discusses these findings in the light of known psychological laws, and by identifying the underlying psychological mechanisms shows how the operational performance might be improved and maintained.

Every conclusion reached is supported by a statistical test of significance, but the author's use of their results is sometimes slightly mechanical and occasionally incorrect. For example, a difference between two percentages is shown to be not significant, and the conclusion is then

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unjustifiably drawn that this difference can *only* be due to chance. Again, a test for the goodness of fit of a negative binomial is applied to some data, and it is said, "The probability level of $P = 0{\cdot}18$ indicates that there is only one chance in five or six against this being a negative binomial curve which suggests a reasonable amount of agreement"—a remark which is curiously confused. In the first place an arithmetical mistake has apparently occurred and the probability is actually greater than $0{\cdot}18$; secondly, it would be more reasonable to say there was one chance in five or six that the curve *was* a negative binomial; and thirdly, even this statement would be incorrect, as is clear if the null hypothesis under examination is carefully considered; no test can give the probability that the theoretical model suggested was in fact the mechanism producing the results observed.

These examples are of small practical importance, but when the trends of performance with time or temperature are under examination a very important issue arises. The author wishes to discover at what point in time, or at what point on the effective temperature scale, performance falls off materially from its initial or normal temperature level. He obtains his answer by considering the statistical significance level of the differences observed between successive times or temperatures; when this is less than 5 per cent. it is concluded that a critical time or temperature has been reached. But clearly the result obtained in this way is a function of the experimental technique as well as of the human performance; had the tests been more sensitive, or had more subjects been used, a shorter time or a lower temperature might have given a statistically significant change of performance. Establishing the statistical significance of a result is *not* the same thing as demonstrating its practical importance. A more effective procedure would have been to define beforehand that degree of change in performance which would be considered of practical importance, and then to deduce confidence limits for the corresponding time or temperature from the trend-line fitted to the results.

Apart from these criticisms of the statistical treatment of the results this is an extremely careful and important piece of work. It illustrates the possibility of applying the methods of experimental psychology in the study of even the most complex of human actions, and of discovering the psychological forces operating, not in isolation, but in the complex setting itself.

P. D. O.

13.—*Epidemics in Schools: An Analysis of the Data Collected during the Years* 1935 *to* 1939. By E. A. Cheeseman. Medical Research Council (Special Report Series No. 271). London: H.M.S.O., 1950. vii + 96 pp. $9\frac{1}{2}''$. 3*s*.

Between 1930 and 1939 the Medical Research Council collected data on the amount of sickness in three types of school: boys' boarding schools, girls' boarding schools and schools for prospective naval candidates. The results of the first five years (1930–34) were published in 1938, and in this present volume, covering the second quinquennium, Dr. Cheeseman has not only analysed and presented the data for the second five years, but has compared and contrasted the later experience with the earlier.

Dr. Cheeseman found that by far the commonest infectious disease was the various manifestations of the common cold, and that in girls' schools the attack rate was more than twice as high as in boys' schools. This sex difference is discussed, and the conclusion drawn that there is better surveillance and reporting of minor illness in girls' schools, and that this is a distinct advantage in that the spread of infectious conditions, particularly measles, is consequently less in them.

Each infectious disease is considered in turn, and it is encouraging to learn that the diphtheria figures were too small over the ten years for any assessment to be made of them. Whooping-cough is found to be commoner in girls, whilst pneumonia, otitis media and scarlet fever are commoner in boys. Many authorities have found that acute and subacute rheumatism is commoner in girls, but the present experience in these schools does not altogether suggest that this is so; if all types of rheumatism, including the muscular form, are considered, then girls have a greater amount than boys, but when acute or subacute articular rheumatism is considered alone, the differences disappear. In both sexes, however, precursor sore throats were common, and there was a high positive correlation of the concurrent incidence of scarlet fever with rheumatism. Of the non-infectious diseases girls had much more vomiting (but not diarrhoea) and twice as much appendicitis. In these diseases the former is much more likely to be emotional, whilst the latter may, again, be brought to light by better surveillance.

Seasonal trends of diseases are given, and it is somewhat surprising that in boys' schools the winter term is freest from disease although it has the highest accident rate (attributed to football); in girls' schools diseases behave similarly, but the accident rate is not higher than in the other terms.

From the experimental work of Major Greenwood *et al.* in 1936 it appeared likely that the

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influx of new entrants each term would be associated with the incidence rates of some of the diseases studied, even though herd resistance may have been lowered in the holidays. Unfortunately it was not possible to examine the sickness incidence of various batches separately. The data were examined for association between "new entrants rate" and the ensuing amount of sickness, but no reliable results were obtained.

When the spread of disease was considered Dr. Cheeseman found that, in boys' schools, measles was most likely to spread, and scarlet fever and whooping-cough least likely. In girls' schools the ability of measles to spread was markedly less, although there were a significantly larger number of single-case outbreaks than in boys' schools. Again, like the boys', the spread of scarlet fever was least in girls' schools. When frequency of outbreaks is considered there was little difference between the schools, except in measles as already mentioned, but there was a high positive correlation in all schools between the size of the school and the frequency of outbreaks.

Further analyses which suggest themselves were not possible as so much of the recorded material was destroyed during the war, but this is a very valuable and clear report which brings to light much new material. J. P. W. H.

14.—*Recent Advances in Social Medicine*. By A. C. Stevenson, B.Sc., M.D., M.R.C.P., D.P.H., with a Chapter by E. A. Cheeseman, B.Sc., Ph.D. London: J. & A. Churchill Ltd., 1950. viii + 241 pp. 8″. 18*s*.

There is much to interest the student, general practitioner and specialist in Professor Stevenson's review of some of the recent progress in Social Medicine. He discusses the effects of clinical advances, legislation and field trial brought together to improve the status of the ordinary citizen.

The only disappointment in this able and readable study is in the lack of inclusion of any chapters on adult problems, and particularly on the new science of geriatrics. Accent is, very rightly, on youth, but some would caution against the results of this tendency in America. Professor Stevenson stresses the emotional and physical reactions to the changeover from school to industry, but this changeover has been immeasurably eased in the past generation. The importance of the parents is not yet fully appreciated in our legislation, but the lack of parental authority (particularly the father) is sadly reflected in the crime and anti-social statistics of to-day. We have still something to learn from the Victorians about family relationships.

Chapter I deals with anthropological measurements, and sound judgment is used in assessing the values of various indices. This chapter is of less general importance and appeal and might well have been relegated to a less prominent part of the book, both because it goes logically with School Medical Inspections (Chapter VII), and because it is on the human sciences Professor Stevenson writes superlatively well.

Prematurity and stillbirths are admirably assessed, but it would have been welcome to have further notes on gastro-intestinal infections and skin conditions in the newborn, for knowledge generally amongst practitioners is deficient in this field.

The pros and cons of day nurseries are discussed, and the inclusion of some statistically dubious investigations in the argument serves only to show the dearth of adequate knowledge on the effects of these nurseries on mental and physical health; the chapter is sound and balanced, and clear conclusions are reached. There follows a chapter on the problems of the unmarried mother: it is in studies of this sort that Professor Stevenson reaches his peak. The problems are discussed without sentimentality, are squarely faced and solutions based on wise judgment found.

Similarly problem families are sympathetically considered, and the pathology of the problem family as possessing a complete lack of initiative clearly shown. This fact is of immense interest: the parents of these families are not vicious or unintelligent, and the attitude to life in general might well be compared with the after-effects of leucotomy in its early days. The psychiatrist might be of help, because at the moment the treatment is in the hands of heroes (or more often heroines), who tackle the degradation and filth single-handed in an attempt to be prime movers towards a desire for an ascent to happier levels. The socially responsible person has no understanding and no sympathy for such parents, and his attitude resembles the medieval one of the attitude to lunatics. Professor Stevenson's account is a ray of light in abysmal darkness, and reminds the reader of the humble beginnings of lunacy reform.

School medical inspections are dealt with at some length, and a firm plan to get the best medical service from the available resources made. This chapter needs serious study by those concerned in the health of the school child, for tremendous advances are waiting to be made. Shorter chapters on psychosomatic illness and the adolescent in industry follow, and a plea is made for at least an X-ray and Mantoux test for juveniles.

Dr. Cheeseman has drawn on his extensive teaching experience to produce a very clear and readable account of recent uses of medical statistics. He discusses social class, mortality ratios

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and simple and multiple regression equations. These are being increasingly used in medical papers, and represent some of the basic essentials of the public health doctor's armamentarium.

In all, this is an excellent book which will help to clarify many nebulous ideas. It is soundly constructive, and written with sympathy and imagination. J. P. W. H.

15.—*The Balance of Payments and the Standard of Living*. By R. G. Hawtrey. London: Royal Institute of International Affairs, 1950. 158 pp. 8½″. 8*s*. 6*d*.

Professor Hawtrey develops a coherent analysis of the way in which our present balance of payments problems spring from certain central weaknesses in our whole economic position. This analysis is original, and brings to the surface factors in our situation which are often ignored—ignored to the detriment of much thinking about solutions.

He finds the roots of our balance of payments difficulties partly in the post-war need for re-equipment (not only mechanical re-equipment, but re-stocking in the broadest sense), partly in the existence of "redundant money" pressing on the limited supply of goods. It is, in his view, the need for re-equipment which has led to an excessive demand for imports. Meanwhile the supply of money to finance this demand was created during the war by forced saving, leading to an accumulation of purchasing power; war-time policy suppressed inflation at the time, but created an inflationary force, in the shape of accumulated savings, which still threatens the equilibrium between current incomes and current production.

There is obviously a close relation between these two factors. The technical need for re-equipment in the mechanical sense was clear enough in the thirties; it is the accumulation of financial resources and the prospects for profit—which were not features of the economy in the thirties—which have converted the technical need into an effective demand.

It is not particularly easy, however, to connect Professor Hawtrey's analysis with the facts of British economic life in the post-war years. He explains the relatively high post-war level of investment. But nearly all this investment has been physically provided from domestically-produced resources. Re-equipment has not in this country produced a direct strain on the balance of payments by increasing our imports of equipment goods (although it has produced such a strain in several other countries). Indeed, one might even say that the truth of Professor Hawtrey's analysis helps to explain why our balance of payments problem has not been even more difficult: the direct demand for imported capital goods abroad has kept up our exports; the need for re-equipment in Britain has led to a transfer of expenditure from consumer goods (with a high import content on average) to capital goods (with a low import content), and has thus helped to keep down our imports. Hawtrey's analysis seems more relevant to our problems of internal balance than to those of our external balance. Obviously one cannot ignore the relation between them, but the intricate mechanics of this relationship might be exposed more clearly.

The importance of suppressed inflation, or "redundant money", in our present problems, internal and external, deserves the emphasis that Hawtrey gives it. It has been neglected partly because, as Hawtrey points out, the dangers of an excessive stock of money seem to have been underestimated in Keynes's *General Theory;* partly, perhaps, because in these days of statistical planning not even an order of magnitude can be ascribed to it. It might be possible, and would be worth trying, to estimate the growth, in money terms, of private wealth in the past 10 years. But even this would not reveal the laws determining the propensity to spend from accumulated money resources. The absence of data has tended to concentrate attention on the "inflationary gaps" shown by the relation between currently produced incomes and current output (in which the influence of the stock of money is only a concealed factor influencing current propensity to save).

Writing within a short time after devaluation, Professor Hawtrey views the experiment with little enthusiasm. His fears may prove justified in the end, but the evidence of one year suggests that parts of his analysis are open to criticism. He points out that devaluation could help only if it increased the dollar proceeds of exports—if the quantities exported rose by more than their dollar prices fell. The policy assumes "that the resources exist and could be turned into the export markets by making prices more remunerative. It fails because the resources are *not* available" (page 105). But in fact the volume of dollar exports *has* increased more than dollar prices have fallen (aided, it is true, by the general economic recovery in the United States). The resources have been derived from additional output.

Professor Hawtrey's view of devaluation, less hopeful than the facts so far justify, is consistent with his general thesis that adjustment of exchange rates is the solution for balance of payments problems which spring purely from monetary causes (like the balance of payments problems of the thirties, of which he provides an illuminating analysis), but is unlikely to be the solution for balance of payments problems originating in more deep-seated weaknesses. These more deep-

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seated troubles, in his view, are those which lead to so heavy a load of domestic demand that no adjustment of exchange rates or prices can restore the foreign balance. Experience seems to show, however, that the weight of the load, in relation to our capacity for expansion of output, has been over-estimated. Whether the economy can so easily cope with the new load of re-armament remains to be seen. C. T. S.

16.—*Investment and Inflation, with Special Reference to the Immediate Post-War Period, Canada*, 1945–1948. (Economic Research Branch, Department of Trade and Commerce, Canada.) Ottawa, 1949. 290 fols. $12\frac{3}{4}''$.

This mimeographed report was prepared by Dr. O. J. Firestone, at the request of the Royal Commission on Prices, which expressed the hope that it would "discuss at some length the effect of the post-war investment boom in Canada upon the movement of prices. It should outline with supporting statistics the factual details of the situation, analyze the factors brought out by the statistical and historical record, and generally weigh all considerations where directly or indirectly the post-war investment boom has influenced the price level in Canada". Any economist will at once agree that this is a very tall order, the relation between the rate of investment and the general price level being largely indirect and exceedingly complex. The reader's first reaction is that Dr. Firestone and his assistants have gone a long way towards satisfying the Commission's directive. This report is really almost a Canadian economic history of the 1930's and 1940's, for it discusses such aspects of investment as productivity, labour relations, population, living standards, industrial structure, level of employment and foreign trade.

The non-Canadian notices particularly the speed of industrialization, forced first by the war, and later by the shortage of U.S. dollars and by the difficulty of obtaining goods from the United Kingdom. Crude steel output at well over 3 million tons per annum is more than twice pre-war; output of building materials and engineering products is three times pre-war; and Canada has been exporting, in some cases to the United States, specialized industrial products such as typewriters, hollow ware, electrical and optical goods, and washing machines. In one matter this report is misleading, however, in that it states that Canada "has been expanding her manufacturing industry at a rate 20 per cent. higher than the United States" (p. 53). "It is only natural that Canadians", the Report goes on, "would endeavour, spurred by the example of achievements across the border, to catch up in terms of productive efficiency and standard of living." The figures on which this conclusion is based are apparently that Canada spent 3·9 per cent. of her gross national expenditure for 1947 and 1948 on investment in manufacturing industry, compared to 3·2 per cent. for the U.S.A. Investment is not, of course, the whole story, but the most relevant comparison if Canada is to "catch up" is in any case between rates of investment, not per cent. of national expenditure, but *per caput*. The report shows that national expenditure *per caput*, assuming exchange parity, was half as great again in the U.S., so that manufacturing investment *per caput* was still substantially lower in Canada, and disparity in productivity and living standards was therefore *ceteris paribus* increasing.

However, the report is mainly concerned with the post-war situation. Here many aspects are very familiar to the reader in the United Kingdom: housing shortage, need for industrial re-equipment, low productivity in building, coal and steel shortages, mal-distribution of labour, even a dollar crisis and import cuts. In brief, Canada had her own problem of over-commitment of resources, and this is analysed in detail of a degree not reached in any diagnosis of our problems. The report provides information of great use for economic analysis such as fixed-price estimates of national expenditure components; details of inventory investment; unfilled employment vacancies by trade; numbers of construction companies working "at", "near" and "below" capacity; months of delay for delivery of various engineering products; and estimates of changes in the number of families. It discusses the developing supply and demand for investment goods in great detail.

Canada dropped her investment controls in December, 1945. While the Government kept a tight rein on its own investment (and tried to persuade Provincial Governments to do likewise), it was somewhat apprehensive about the immediate business future (doubtless under the influence of pessimistic forecasts in the U.S.), and adopted a range of stimulants to private investment, especially tax concessions and cheap money. For steering investment it relied mainly on differential rates of depreciation allowance. By 1946 it was clear that the danger was inflation, not deflation, and the Government's policy became "mildly deflationary". Some special depreciation allowances were made conditional on postponement of construction; budget surpluses were achieved; money became dearer; housing policy became more cautious; and industry was asked to postpone investment. A major instrument of investment control came rather unexpectedly to hand when the acute U.S. dollar shortage of 1947 led to import control and the refusal

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of licences for capital goods going into non-essential industries. Much of the report defends these partial controls against those who wanted more or less. Although in many ways the problems were like Britain's, an economy with real consumption *per caput* 50 per cent. above pre-war obviously has an almost luxurious amount of room to manoeuvre. Whatever the *ex-ante* justification, it would be seen, on the evidence presented, superfluous to defend *ex-post* the substitution of the inflationary special depreciation allowances for direct control of investment.

The treatment of the inflationary aspect of "Investment and Inflation" is incomplete, the title being rather misleading. The choices posed by a large investment outlay, accounting for one-sixth of the country's resources, are never fully raised, and what discussion there is seems confused. For one thing, the extent of excess demand is perhaps exaggerated. Thus an illustrative example is given of the effects of a 10 per cent. cut in investment on the cost-of-living index, but no allowance is made for the deflationary impact of a transfer of resources to consumption. The reason for this omission may have been the view that exports and domestic durables would have taken up the slack, so that "the *total level* of demand would still have led to inflationary pressures" (p. 211). This analysis appears to overlook that the excess of consumers' demand in such a situation is only marginal, and can be greatly mitigated by relatively small increases in supply. More fundamental a flaw is a confusion between "inflation" as an apparent overall deficiency of goods, the direct outcome of an investment boom, and "inflation" as a set of rapid price rises, the indirect result. Thus: "The effect of high world prices appears to have been a more significant factor [than investment] contributing to inflation" (p. 20).

This confusion enables the Report to exonerate the Government by implication, since "it would be misleading to blame any one factor for inflation". If "inflation" is defined as rising prices, the blame is indeed a world rather than a Canadian matter, but "inflation" as internal excess of demand was by no means inevitable. The alternative conclusion, which almost forces itself through the report, is that Canada could have had her industrialization without a chronic sellers' market developing if she had avoided either inessential investment (by a licensing system) or inessential consumption (by taxation). D. S.

17.—*The Home Market.* By G. Harrison and F. C. Mitchell. 1950 Edition: Revised and written by M. A. Abrams, Ph.D. [London: Allen & Unwin, 1950. x + 82 pp. 10½". 15*s*.

It is eleven years since the previous edition of this book presented to manufacturers and advertisers a collection of social and economic data of value to them in their task of selling in the home market. The current edition, like the two which have preceded it, contains a wide range of data derived from various sources, summarized into 21 sections. A considerable degree of uniformity with previous issues is maintained, in that the first sections are concerned with age and sex composition and regional distributions of the population. Regional average household sizes are given together with estimates of the numbers of persons not living in private households. Regional income grades and distributions of employed working population are indicated, after which appear some data on consumers' income and expenditure, household budgets and the distribution of press readerships.

It seems that, in most instances, the data relate to 1947 or 1948, but the date of origin and the sources are by no means always clear; population data are based on January, 1949, figures—presumably the Registrars'-General estimates at this date.

Perhaps it is unfortunate that this book is in fact described as the third edition of the *Home Market*. If it had been intended to appeal to a different market it would have been better to have issued it under a different title, since comparisons between it and the 1939 edition would then have been less likely to have been made. There are both qualitative and quantitative differences bewteen this and the preceding issue which are significantly disadvantageous to the present edition. Since, however, the authors have decided to present this book in this way, they will probably not complain if comparisons are made.

The current edition contains only about half the number of pages—82 as against 152—and very little attempt has been made to re-space the data so that the loss of information could be minimized. It therefore appears that the omissions are intentional, or that it was found impossible to maintain the comparability because of factors outside the control of the authors. This is particularly unfortunate, since the data which appeared in 1939 and do not now appear are mainly those which are not obtainable from other sources. For example, the interesting estimates of county and some town income distributions which were a feature of the earlier edition do not appear, and only broad regional estimates are given. The retail sales index is given, but not the related income distribution estimates. Some other omissions are: the distribution of family size by region, purchasing power indicators, and current statistical sources of commercial interest.

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The family budgets data are reduced, and although some compression has been achieved here, the reduction of the data to one table results in a significantly lower content.

It is realized that the purchasing power indicators of Unemployment and Poor Relief which have been omitted from the present issue would have little or no meaning to-day in conditions of full employment. It might, however, have been hoped that research would have found some other indicators which could have been used by the business man in the present conditions to differentiate between towns or areas of relatively high purchasing power and those which are below average. It seems that from the point of view of most business men a good estimate of the purchasing power of a large territory (such as the regions where income distributions are quoted) is often not so useful in practice as a less reliable one which may be used to indicate differences between smaller areas. It is to be hoped that the authors will later be able to supply such information.

Statisticians may wonder why whole pages are given over to maps which give only about a dozen facts, which in any case are repeated on the facing page, especially if this meant reducing other material and the omission of such a large proportion of interesting estimates and data.

A feature of the earlier edition, the absence of which in the current one is much regretted, is the clear statement of sources which used to appear at the head of each section. Some sources are now stated in the text and others implied in footnotes, but others were searched for in vain. Not all those which were unfound were obvious, indeed some could not be guessed at all. Another regretted omission is the explanation of the methods whereby the estimates were derived. The previous edition devoted sixteen pages to general information on sources, and twenty-six pages to descriptions of the methods of estimation and the like. It may have been regarded that the sources did not need revision and reprinting, but the omission of the sources of the basic tables in a number of instances is a matter which should be put right on the next issue. It must be assumed that certain data are based on sample survey figures, and although the information is presented for the use mainly of people who are not statisticians, some of the requirements of the United Nations Statistical Sub-Commission on Sampling could have been unobtrusively met. The sample size is not given, the system of sampling is not stated, nor can it be found whether postal questionnaires or interviewing techniques were used. There is thus no information which can lead to an appreciation of the likely error components of the figures. There is no reason to believe that the data given are not good, and that the estimates made have not been well made, but with no reference to the sources and no explanation of the methods of estimation the reader can only take his information on trust. Most will be prepared to do this, but perhaps the sceptics would be more prepared to trust if sources and explanations were given, even if they did not refer to any nor read about the methods. The main difficulty which arises from these two major omissions is that a reader who may commence calculations based on data in the book, and later find that he needs more than can be found there, is not helped to additional or basic sources for the completion of his analysis.

It is too often the predictor's fate to go into print and later to be found to be wrong, but perhaps a glasshouse dweller may be allowed one parting stone! The 1939 edition estimated the 0–15 age-group population at 1950 to be 6·6 million, and it is no fault of the authors that they have now to record the 1949 population for this group at 10·6 million. Perhaps it is mainly for this reason that your reviewer wishes that the title had been changed, since then the uninitiated would have been less likely to observe this fact!

L. T. W.

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STATISTICAL NOTES

British Official Statistics

The interim index of retail prices compiled by the Ministry of Labour and National Service stood at 114 in July, the same level as in the preceding three months, fell to 113 in August and rose again to 114 in September. Actually, the changes were fractional, but they caused variations of one whole point in the index quoted to the whole number. The change in August was mainly due to substantial reductions in the prices of potatoes, apples and oranges, but these were partly offset by advances in the prices of some kinds of clothing and in electricity charges in some areas. The rise in September occurred mainly in the price of butter and bacon, some kinds of clothing and coal. In showing a slight decrease in August, the food index is following the usual seasonal pattern, although in 1949 it moved in the opposite direction. The detailed figures for July, August and September were as follows:

(*Prices at June 17th, 1947 = 100*)

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Drink and Tobacco*	*Total*
Weights:	348	88	97	65	71	35	79	217	1,000
July 18th, 1950	122·3	101·3	119·4	114·9	112·9	112·9	108·2	103·9	114
Aug. 15th ,,	120·9	101·3	119·9	115·7	113·0	112·9	108·4	103·9	113
Sept. 12th ,,	122·1	101·4	120·7	116·8	113·3	112·9	109·6	103·9	114

In publishing the figures, the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e. to the nearest first place of decimals. The decimals are shown in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attached to the decimals, and for any other purposes, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates remained unchanged at 110 (June, 1947 = 100) from the beginning of 1950 to the end of September. In 1949 the figure rose by 2 points, and in 1948 by 4 points. The index at the end of September stood at 110 for men, 114 for women and 114 for juveniles.

The index of average weekly earnings at April, 1950, was 120 (April, 1947 = 100), the figure for men being 118, for women 120 and, for juveniles, 130. The actual average earnings, in the industries covered by the Ministry of Labour inquiries, in April, 1950, was as follows:

	Men	*Youths and Boys*	*Women*	*Girls*	*All Workers*
Weekly earnings . .	145*s.* 9*d.*	61*s.* 5*d.*	80*s.* 6*d.*	51*s.* 10*d.* .	124*s.* 1*d.*
Hourly earnings . .	37*s.* 2*d.*	16*s.* 7*d.*	23*s.* 1*d.*	14*s.* 6*d.* .	32*s.* 7*d.*

These averages show increases of 133 per cent. in weekly earnings and 139 per cent. in hourly earnings over October, 1938. The average hours worked in April, 1950, were 45·6. They have shown a gradual rise since April, 1947, when the average was 45·0. It is interesting to note that the average hours worked have only fallen from 46·5 in October, 1938, to 45·6 in April, 1950, in spite of a reduction in the weekly normal hours from 47 or 48 to 44 or 45.

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The total working population and the numbers in civil employment at recent dates, compared with mid-1948, when the new series of man-power figures started, have been as follows:

Thousands

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Mid-1948	16,057	7,089	23,146	14,945	6,981	21,926
June, 1950	16,055	7,270	23,325	15,184	7,170	22,354
July, ,,	16,062	7,272	23,334	15,190	7,169	22,359
Aug. ,,	16,103	7,303	23,406	15,225	7,193	22,418

The total working population rose by 9,000 between June and July (7,000 males and 2,000 females) and by 72,000 (41,000 males and 31,000 females) between July and August. The number in civil employment was 5,000 higher in July than in June and showed a further rise of 59,000 in August.

The level of unemployment, which had been falling steadily since the beginning of the year, rose by 16,336 in August and fell by 4,476 in September. The figure was 81,431 less than in January, 1950.

Number of Unemployed Persons on the Registers of the Employment Exchanges of the Ministry of Labour and National Service

Date	*Men and Boys*	*Women and Girls*	*Total*
June 12th, 1950	201,771	80,225	281,996
July 10th, ,,	196,327	75,648	271,975
Aug. 14th ,,	201,330	86,981	288,311
Sept. 11th ,,	196,511	87,324	283,835

The figures do not include registered seriously disabled persons who are unlikely to obtain work except under special conditions.

It is estimated that the number of unemployed persons on the registers at September 11th represented 1·4 per cent. of the total number of employees insured under the national insurance schemes. The percentages in the various Regions ranged from 0·5 in the Midlands and North Midlands to 2·6 in the Northern Region, 2·7 in Scotland and 3·4 in Wales.

A series of figures has become available from the Ministry of National Insurance relating to the incidence of absence due to sickness and industrial injuries. They show the estimated numbers of insured persons absent from work from these causes at monthly intervals. The figures relating to absence owing to sickness cover not only employed persons but also self-employed persons. They show a marked seasonal increase in January to April, 1950, when they ranged from 968,600 in April to 1,080,700 in February. The figure fell to 795,400 in July and rose to 817,000 in August and 831,700 in September. It is not practicable to measure the precise loss due to sickness amongst the employee population, but the figures suggest a sickness absence of between 4 and 5 per cent. The figures relating to absence owing to industrial injuries cover only the employed class. This year they have ranged from 60,700 in June to 67,300 in February.

The Board of Trade have announced that, following the practice which was usual in pre-war years, they have made one of the periodic changes in the base year used in the calculation of the index numbers of the volume of United Kingdom overseas trade. From 1945, when the publication of these index numbers was resumed after the war, to 1949, the base year of the index numbers was 1938 and the prices of that year were used as weights. The change now announced means that from the beginning of 1950 the index numbers are being computed using the prices of the year 1947 as weights; index numbers on the new basis have also been computed for 1948 and 1949. In announcing the change the Board of Trade have also prepared a note describing the method of calculation of the volume index numbers and of the average value index numbers which are derived from the same calculations; this note, together with the results of a detailed comparison of trade in the old and new base years and tables giving the new index numbers for the years 1948–1949, is available on application to the Statistics Division of the Board of Trade, Thames House (North), Millbank, London, S.W.1.

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The *General Report* on the 1931 Census of England and Wales, which was published in March, 1950, from the General Register Office (price 10*s.* net), completes the series of volumes on the last census. Its publication has been delayed, first by the need to prepare the supplementary series of County Volumes which showed the changes due to the Local Government Act of 1929, and later by wartime work on the national registration system. Printing restrictions during the war meant that arrears of publications which had accumulated during the war years have had to be made up since 1945, thus causing a further delay in the publication of the *General Report*. The commentary in the new volume covers the whole field of the 1931 census except the statistics on housing, to which a previous volume in the National Series has been devoted. Of particular interest, in view of the approaching census of 1951, is the section dealing with the preparation and procedure of the last census, and the system of tabulation and analysis of the results. It is worth recalling that the original scope of the 1931 census was rather smaller than that of 1921, owing to the possibility of another census in 1936, and it was further reduced because of the economic situation. One of the most fascinating features of the analysis of the census figures is the curious bias in reported ages. A deficiency of ages ending in 1 and a corresponding surplus of those ending in 0 is perhaps not very surprising, but the tendency to avoid the 7's and favour the 8's is rather strange.

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CURRENT NOTE

A useful series of essays in applied economics and statistics is brought together in the first number of *Staff Papers* (Vol. I, No. 1), published by the International Monetary Fund (annual subscription, for three numbers, $3.50, obtainable from the Secretary, I.M.F., 1818, H Street, Washington 25, D.C.). The seven papers, written at various times in the past two years by members of the I.M.F. staff, represent the views of the authors and not necessarily the position of the Fund. They deal principally with problems of international trade, but include also theoretical and statistical analyses of the problems of internal balance.

Perhaps the most interesting statistical paper is "The Measurement of Inflation," by J. Keith Horsefield. He takes as measurable "inflationary forces" the budget deficit (or surplus, as a negative quantity), net investment, and the foreign surplus (or deficit), all expressed as percentages of national income.

His object is to see whether these inflationary forces could be balanced by the amount of saving that would take place without inflation. This is not directly measurable, but he assumes that, broadly speaking, it is unlikely to represent in current conditions an increasing proportion of national income. Hence an increase in the sum of the three inflationary forces is *prima facie* evidence of net inflationary pressure. Estimates are given for several European countries, including the U.K., for 1938, the war years, and 1946 to 1948. The result shown, at first sight strange, is that the inflationary forces in these countries were not substantially greater in 1947 or 1948 than in 1938. The much higher levels of investment in 1948 were sustained chiefly by foreign deficits made possible through E.R.P. aid (Belgium, Norway, France, Netherlands), or by the conversion of a budget deficit into a surplus (the United Kingdom). Some of the statistics for the war period in the occupied countries are of particular interest, notably the calculations of occupation costs (including unrequited exports), which amounted in Belgium, France, Netherlands and Norway to 40–50 per cent. of national income—proportions comparable with the military expenditure of the U.K. in the same period.

In a paper on "The effect of exchange depreciation on a country's export price level," J. J. Polak and T. C. Chang try to show from European experience in the twenties and thirties how far the reduction of relative export prices made possible by depreciation is likely to be offset by higher internal costs. They show how the effect varies principally with the degree of activity in the depreciating country. When the U.K. devalued in the slump of 1931 the fall in relative export prices was successfully maintained. On the other hand, in the French devaluation of 1936, when the "Blum experiment" created rather artificial full employment, the rise in French relative export prices almost at once rendered the depreciation ineffective.

A paper on the "Role of the E.C.A. Program" includes a useful summary of E.C.A.-financed shipments to Europe, but the data extend only to May, 1949. A paper on the "Terms of trade in Latin-American countries" demonstrates principally the lack of reliable up-to-date statistics of foreign trade of many Latin-American countries. Other papers deal with the problems of "latent inflation" (the often neglected influence of the accumulation of forced saving by firms and individuals during war), the ways in which the use of "local currency proceeds of an import surplus" (e.g. the E.C.A. "counterpart funds") can cause inflationary pressure, and the constitutional relations between the I.M.F. and the International Trade Organization.

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STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

July 1950—The use of sampling methods in national income statistics and social accounting: *R. Stone, J. E. G. Utting* and *J. Durbin*. The classification of assets: *A. A. Fitzgerald*. American experience in personnel testing for accounting work: *H. R. Caffyn* and *A. E. Traxler*. Replacement cost depreciation: *A. R. Prest*. Direct taxation and the inflationary and deflationary effects of fiscal policy: *L. T. Little*.

British Journal of Psychology (Statistical Section)—

June 1950—Tests of significance in factor analysis: *M. S. Bartlett*. A method of standardizing group-tests: *D. N. Lawley*. Linear and non-linear discriminating functions: *A. Lubin*. The influence of differential weighting: *C. Burt*. Note on Sir Cyril Burt's paper on Differential Weighting: *G. Thomson*. A reply to Sir Godfrey Thomson's Note: *C. Burt*.

British Journal of Social Medicine—

April 1950—The care of the chronic sick: *C. R. Lowe* and *T. McKeown*. The sex ratio of human births related to maternal age: *C. R. Lowe* and *T. McKeown*. The total lung volume and its subdivisions, II: *A. G. W. Whitfield, J. A. H. Waterhouse* and *W. M. Arnott*.

Eugenics Review—

July 1950—The quality of the rural population: *B. Bosanquet*.

Institute of Actuaries, Journal—

Vol. LXXV, Part II, No. 341—Methods of forecasting mortality using Australian data: *A. H. Pollard*. Some thoughts on the analysis of numerical data: *L. G. K. Starke*. Alfred Watson Memorial Lecture.

Vol. LXXVI, Part I, No. 342—The development of public superannuation schemes: *A. C. Robb*. Report of the Royal Commission on Population: Abstract of Discussion. Graunt's life table: *D. V. Glass*. The recent trend of mortality in England and Wales: *W. S. Hocking*.

Oxford University Institute of Statistics, Bulletin—

May 1950—A "human needs" diet in spring 1950: *T. Schulz*. The national income: first quarter of 1950: *D. Seers*.

June 1950—"Human needs" of a single person: *T. Schulz*. The post-war cost-of-living: *D. Seers*. Index numbers of the cost-of-living, 1948–9: *D. G. Holland*.

Review of Economic Studies—

Vol. XVII (2), No. 43—The cost of a family: *A. M. Henderson*.

Royal Society of Edinburgh, Proceedings—

Vol. LXIII, Part I—The stability of solutions of non-linear difference-differential equations: *E. M. Wright*. The simplest form of second-order linear differential equation, with periodic coefficient, having finite singularities: *E. Cambi*. Studies in practical mathematics. V. On the iterative solution of a system of linear equations: *A. C. Aitken*. Les transformations asymptotiquement presque périodiques discontinues et le lemme ergodique. (Première note): *M. Fréchet*. Unbiased statistics with minimum variance: *A. Bhattacharyya*. A further note on a problem in factor analysis: *D. N. Lawley*.

AUSTRALIA—

Economic Record—

June 1950—A wages policy for Australia: *J. E. Isaac*. The Australian inflation and Commonwealth finance: *W. R. Lane*. National output, income and expenditure of N.S.W., 1891: *H. W. Arndt* and *N. G. Butlin*. Import control in New Zealand, 1938–1950: *R. F. Wilson*. Australian-American trade relations, 1791–1939: *L. G. Churchward*. Interstate differentials in human fertility in Australia: *R. J. Linford*. Full employment in New Zealand: *N. Ruth*.

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INDIA—

Sankhyā—

March 1950—Statistical analysis of some physiological experiments: *A. Linder* and *E. Grandjean.* On a problem of two dimensional probability: *R. C. Bose.* Univariate and multivariate analysis as problems in testing of composite hypotheses. I: *S. N. Roy.* The theory of fractional replication in factorial experiments: *C. R. Rao.* A note on the fractional replication of factorial arrangements: *K. S. Banerjee.* Two dimensional systematic sampling and the associated stratified and random sampling: *A. C. Das.* Economic classification of agricultural regions in Bengal: *A. Ghosh.* A statistical analysis of the family budgets of industrial workers at Nagpur: *N. C. Chaudhuri.* Relation between death and birth rate in Bengal: *P. G. Chowdhury.* On methods of handling algebraic signs on the Hollerith Multiplier: *A. Matthai.*

UNION OF SOUTH AFRICA—

South African Journal of Economics—

June 1950—Economic revolution: *A. J. Limebeer.* A survey of the law relating to the control of monopoly in South Africa: *D. V. Cowen.* The international wheat agreement: *A. W. O. Bock.* A study of absenteeism amongst women in commerce: *V. G. Pons.*

UNITED STATES—

American Academy of Political and Social Science, Annals—

July 1950—Formulating a point four program. (Whole number.)

American Statistical Association, Journal—

June 1950—A technique for making extensive population estimates: *D. J. Bogue.* Are there two regressions?: *J. Berkson.* Some new aspects of the application of maximum likelihood to the calculation of the dosage response curve: *J. Cornfield* and *N. Mantel.* Probability values for the common tests of hypotheses: *T. A. Bancroft.* On the measurement of the productivity of labor: *S. P. Zobel.* Large sample tests and confidence intervals for mortality rates: *J. E. Walsh.* Statistical decisions by the method of minimum risk: an application: *R. C. Sprowls.* Interference with a controlled process: *P. C. Hammer.* Sample size required for estimating the standard deviation as a per cent. of its true value: *J. A. Greenwood* and *M. M. Sandomire.* Estimating birth registration completeness: *S. Shapiro.* The degree of stereotypy: *J. E. Freund.*

Biometrics—

June 1950—Estimation of bacterial densities by means of the "most probable number": *W. G. Cochran.* Statistical analysis in sanitary engineering laboratory studies: *R. Eliassen.* The application of statistical techniques to sewage treatment processes: *J. W. Fertig* and *A. N. Heller.* Fiducial intervals for variance components: *I. Bross.* Transformations in studies on weight per locule of tomato fruit: *L. Powers.* Proceedings of the Second International Biometric Conference continued: Recent applications of biometrical methods in genetics: (1) Experimental techniques in plant improvement: *F. Yates;* (2) The analysis of selection curves: *L. L. Cavalli;* (3) Scores for the estimation of parameters: *D. J. Finney.* Industrial applications of biometry: Biometric methods in chemical industry: *O. L. Davies.*

Econometrica—

July 1950—Empirical determination of a multidimensional marginal cost function: *A. R. Ferguson.* Stock and flow analysis in economics: *L. R. Klein.* Stock and flow analysis; comment: *W. Fellner* and *H. M. Somers;* Further comment: *L. R. Klein;* Discussion: *K. Brunner;* Note on the discussion: *W. Fellner* and *H. M. Somers.* Risk allowances for price expectations: *P. B. Simpson.* A note on brand-names and related economic phenomena: *G. K. Zipf.*

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Estadística—

March 1950—Inter-American Statistical Congress, Bogota, January 1950: Summary and resolutions. From population estimates to the 1950 Census of the Americas: *A. A. Parró*. Propuesta de un coeficiente de exactitud: *E. Michalup*. Some aspects of Haiti's population and national territory significant in census considerations: Chapter II, population characteristics: *C. W. Young*. Notas sobre el cálculo de tasa de fecundidad de los datos del censo de 1950: *L. E. Truesdell*. Population and housing subjects in the Seventeenth Decennial Census of the United States.

June 1950—Proyección y tabulación de los censos de 1950 con miras a las investigaciones por muestreo: *R. G. Frias*. The national income of Mexico: *H. G. Aubrey*. Regiones ecónomicas de producción y consumo agropecuario con base en la coordinación de los censos de 1950: *J. Q. Caballero*. Some aspects of Haiti's population and national territory significant in census considerations: Chapter III, territorial divisions: *C. W. Young*. Discurso de clausura del Segundo Congreso Interamericano de Estadística pronunciada por el Dr. Ordoñez Ceballos.

Harvard Business Review—

July 1950—Accounting for the cost of pensions—a lien on production: *A. H. Dean*. Prospects for long-term foreign investment: *H. J. Dernburg*. Business needs for venture capital: *W. F. Butler* and *R. P. Ulin*. Management and the public stockholder: *L. D. Gilbert*. Formula plans and the institutional investor: *C. S. Cottle* and *W. T. Whitman*. Big business and small business; a case study: *R. Schlaifer*. New approach to employee health programs: *R. J. Clarke* and *D. W. Ewing*.

Journal of Experimental Education—

June 1950—Factor analyses of prospective teachers' differences: *J. Schmid, Jr.*

Mathematical Tables and other Aids to Computation—

July 1950—Matrix inversion by a Monte Carlo method: *G. E. Forsythe* and *R. A. Leibler*. Maximum-interval tables: *D. H. Sadler*. Planning and error considerations for the numerical solution of a system of differential equations on a sequence calculator: *F. J. Murray*.

Psychometrika—

March 1950—Sequential sampling plans for use in psychological test work: *A. W. Kimball*. The calculation of sums of squares for interactions in the analysis of variance: *A. L. Edwards* and *P. Horst*. A factorial study of the Multiphasic, Strong, Kuder, and Bell inventories using a population of adult males: *W. C. Cottle*. A device for facilitating the computation of the first four moments about the mean: *J. Lyman* and *P. V. Marchetti*. A note on the calculation of weights for maximum battery reliability: *B. F. Green, Jr.* A note on the measurement of reversals of perspective: *J. S. Bruner, L. Postman*, and *F. Mosteller*.

June 1950—Regression tests for several samples: *H. Gulliksen* and *S. S. Wilks*. Test reliability and correction for attenuation: *H. G. Johnson*. On the identification of parameters in Thurstone's multiple factor analysis: *O. Reiersøl*. Bias and error in multiple-choice tests: *C. H. Hamilton*. Connectivity and generalized cliques in sociometric group structure: *R. D. Luce*. On the effect of selection performed on some coordinates of a multi-dimensional population: *Z. W. Birnbaum, E. Paulson*, and *F. C. Andrews*. The relation of the Psychometric Society to the Federation of Statistical Societies.

Quarterly Journal of Economics—

May 1950—European unification and the dollar problem: *A. Smithies*. Soviet national income and product in 1937, Part I; National economic accounts in current rubles: *A. Bergson*. The recruitment of the American business elite: *W. Miller*. The interindustry wage structure: Forces affecting the interindustry wage structure: *A. M. Ross* and *W. Goldner*. A theory of interindustry wage structure variation: *J. W. Garbarino*.

FRANCE—

Journal de la Société de Statistique de Paris—

May–June 1950—Étude statistique des chambres de compensation bancaire en France et à l'étranger: *C. Penglaou*. Les élasticités par rapport aux prix dans les échanges internationaux: *E. Malinvaud*. Recherches statistiques sur l'identification des encres au campêchechrome: *L. Amy*.

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Population—

April–June 1950—Besoins et possibilités de l'immigration française (1re partie): *A. Sauvy.* Les diables de Malthus. Remarques sur les aspects démographiques de la théorie de l'emploi: *G. Ardant.* La famille normale: *P. Vincent.* L'enquête d'Indianapolis sur la fécondité: *C. V. Kiser.* Géographie de la population et démographie: *P. George.* Productivité et population: *J. F. Gravier.* Le problème de la mortalité génétique périnatale: *J. Sutter* and *L. Tabah.* Le problème démographique et l'évolution du sentiment public: *A. Girard.*

GERMANY—

Allgemeines Statistisches Archiv—

Vol. 34, No. 1—Über den Grenznutzen der mathematischen Statistik: *A. Schwarz.* Einige Bemerkungen zum Aufsatz von Dr. Arnold Schwarz "Über den Grenznutzen der mathematischen Statistik": *O. Anderson.* Besprechung des Aufsatzes von Dr. Schwarz: *H. V. v. Guérard.* Zur problematik eines Einzelhandelspreis- und Lebenshaltungskostenindex: *P. Deneffe.* Ausgeloste und unausgelöste Statistik: *K. Krieger.* Und dennoch mehr Vorsicht mit Indexzahlen: *O. Anderson.* Die fachliche Darstellung industriestatistischer Erhebungsergebnisse: *K. Wobbe.* Die Messung der industriellen Produktionsleistung: *G. v. Pokorny.* Die statistische Fakultät der Universität Rom: *F. Pedroni.*

Mitteilungsblatt für Mathematische Statistik—

Vol. 2, Part 1—Die Grundprobleme der Stichprobenmethode, III: *O. Anderson.* Die typischen Schlussweisen der mathematischen Statistik, IV: *H. Münzner.* Elementare Ausführungen zur Theorie und Technik des Stichprobenverfahrens, III: *H. Kellerer.* Eine neue Variante der Saisonbereinigung von statistischen Zeitreihen: *O. Anderson, jun.* Thermodynamik, Quantenstruktur und Wahrscheinlichkeit: *H. von Guérard.* Nochmals zum Problem des "Wahrmetodes": *O. Anderson.*

HOLLAND—

Statistica—

Vol. 4, No. 1–2—Statistiek in Suid-Afrika: *B. de Loor.* Enkele statistische problemen in de textielindustrie: *A. R. van der Burg.* Is diptherie een vermijdbare ziekte?: *D. Hoogendoorn.* Het gebruik van bewegende gemiddelden voor de analyse van een economische grafiek: *J. M. Storch.* Het gebruik van één-en tweezijdige overschrijdingskansen bij het toetsen van hypothesen: *J. Hemelrijk* and *H. R. van der Vaart.* The role of statistics as a tool of management: *J. M. Juran.* Een voorstel tot normalisatie van de symbolen in de "statistica" en de "biometrica": "*Normalisatie Commissie* 73." (English summaries.)

ITALY—

Giornale degli Economisti e Annali di Economia—

March–April 1950—La durata del capitale fisso e gli effetti dei tributi: *A. Scotto.* Il metodo delle trasformate euleriane di prima specie ai fini della rappresentazione analitica delle curve di concentrazione: *V. Amato.*

May–June 1950—Sulle funzioni quasi-periodiche nell'economia in sviluppo: *G. Demaria.* Prospettive e problemi della produzione degli idrocarburi in Italia: *M. Boldrini.* Semplificazione di alcuni procedimenti minimizzanti che concernono l'economia dei trasporti: *L. Galvani.* Indici di concentrazione: *F. Giaccardi.* Disoccupazione e piena occupazione: *G. F. Vella.*

Statistica—

April–June 1950—Intorno ad una recente indagine sulla rivoluzione dei prezzi a Catania dal 1512 al 1630: *V. Amato.* Un capitolo anglo-sassone della statistica da revisionare e le tendenze moderne della statistica ufficiale: *V. Castellano.* Sui limiti di applicabilità della formula di Poisson: *V. Amato.* Lo statistico come organizzatore dell'azienda: *F. Pedroni.* Aspetti e problemi dell'economia spagnola attraverso i dati della statistica agraria: *L. Grifone.* I consumi alimentari in un gruppo di dieci famiglie urbane: *G. Bonifacio.*

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JAPAN—

Institute of Statistical Mathematics, Annals—

Vol. I, No. 1 (*August* 1949)—On an analytical method in the theory of independent random variables: *K. Kunisawa.* Note on the independence of certain statistics: *K. Matusita.* On the independence of bilinear and quadratic forms of a random sample from a normal population: *J. Ogawa.* On the criteria of the independence and the degrees of freedom of statistics and their applications to the analysis of variance: *H. Sakamoto.*

Vol. I, No. 2 (*March* 1950)—A survey method using two kinds of surveys: *H. Midzuno.* Fragments of a new test formula of normality: *C. Hayashi.* Representation of a function by the Fourier-Stieltjes integral: *T. Kawata.* A remark to the Wald's theory of statistical inference: *K. Matusita.* An outline of the theory of sampling systems: *H. Midzuno.* On a limit of distribution: *T. Ugaheri.*

SWITZERLAND—

Schweizerische Zeitschrift für Volkswirtschaft und Statistik—

June 1950—Empirische Konsum—und Sparfunktionen: *C. la Roche.*

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LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part III, 1950, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Colonial Office. The British territories in East and Central Africa 1945–1950. London, H.M.S.O., 1950. Cmd. 7987. iv, 166 pp. 9½″. 4*s*.

Commonwealth Economic Committee

Meat: a summary of figures of production, trade and consumption relating to beef, live cattle, mutton and lamb, live sheep, bacon and hams, pork, live pigs, canned meat, offals, poultry meat ... 1950. xiii, 101 pp. 9½″. 5*s*.

Plantation crops: a summary of production trade and consumption relating to sugar, tea, coffee, cocoa, spices, tobacco and rubber ... London, H.M.S.O., 1950. xi, 103 pp. 9½″. 5*s*.

Medical Research Council. Reports on biological standards: VI. The design of toxicity tests; by W. L. M. Perry. (Special Report Series, 270.) London, H.M.S.O., 1950. vi, 51 pp. 9½″. 1*s*. 6*d*.

Meteorological Office. Upper winds over the world, by C. E. P. Brooks ... C. S. Durst ... N. Carruthers ... D. Dewar ... and J. S. Sawyer ... (Geophysical Memoirs, 85.) London, H.M.S.O., 1950. ii, 150 pp. charts. 11″. 17*s*. 6*d*.

Scientific and Industrial Research, Dept. of. Reports of the Forests Products Research Board, with the reports of the Director of Forests Products Research for the years 1939–1947. London, H.M.S.O., 1950. vii, 94 pp. 9½″. 3*s*. 6*d*.

Scottish Home Department. A programme of Highland development. Edinburgh, H.M.S.O., 1950. Cmd. 7976. 34 pp. 9½″. 1*s*. 6*d*.

Scottish Home Department and Board of Trade. Final report of the committee of inquiry into the tenure of shops and business premises in Scotland. Edinburgh, H.M.S.O., 1950. 18 pp. 9½″. 6*d*.

Trade, Board of. Report to the President of the Board of Trade by the United Kingdom Industrial Mission to Pakistan, 1950. London, H.M.S.O., 1950. 79 pp. maps. 9½″. 7*s*.

(b) Other National and International Publications

Belgium

Institut National de Statistique. Recensement général de la population, de l'industrie et du commerce au 31 décembre, 1947. Tome I. Brussels, 1949. 415 pp. 11½″.

British Honduras

West Indian census, 1946. Part E. Census of British Honduras 9th April, 1946. Belize, 1948. xliv, 36 pp. 13″. 60 *cts*. (Presented by the Colonial Secretary.)

Falkland Islands

Report of 1946 census. Stanley, 1946. 20 pp. 13″. (Presented by the Colonial Secretary.)

Fiji

Legislative Council

A report on the Fiji census, 1936 ... Suva, 1936. viii, 89 pp. maps. 13″.

A report on the results of the census of the population 1946 ... Suva, 1947. viii, 222 pp. maps, tables, schedules. 13″. (Presented by the Colonial Secretary.)

Gold Coast

Census of population 1948. Report and tables. Accra, 1950 (London, Crown Agents). 422 pp. 13″. 10*s*. 6*d*.

Jamaica

Central Bureau of Statistics. Eighth census of Jamaica and its dependencies, 1943. Population, housing and agriculture. Kingston, 1945. 571 pp. maps. 13″. 12*s*.

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Leeward Islands

West Indian census, 1946. Part F. Census of the Leeward Islands, 9th April, 1946. Kingston, Jamaica, Government Printer, 1948. lx, 63 pp. 13″. 3*s*. (Presented by the Colonial Secretary.)

Punjab (Pakistan)

Board of Economic Inquiry. Agricultural statistics of the Punjab, Pakistan, 1901–02 to 1946–47 (Publication 97.) Lahore, 1949. ii, ii, 112 pp. 9¾″. 3*s*.

St. Helena

Census of population of St. Helena Island and Ascension Island, 1946. St. Helena, [1947]. [11 pp.] 10″. (Presented by the Government Secretary.)

Seychelles

Colony of Seychelles census report for the year 1947 ... Victoria, 1948. 15 pp. 13″. (Presented by the Secretary to the Government.)

Singapore

Department of Social Affairs. A social survey of Singapore: a preliminary study of some aspects of social conditions in the municipal area of Singapore, December, 1947. Singapore. viii, 165 pp. table, map. 8¼″.

Trinidad and Tobago

Colony of Trinidad and Tobago census album containing a brief geographical, historical and economic review of the Colony of Trinidad and Tobago with meteorological observations, vital, trade and other statistics and 75 maps based on the 1946 census ... Compiled by Noel P. Bowen ... B. G. Montserin ... Port of Spain, 1948. 114 folios. 14¾″ × 18″.

Union of South Africa

Office of Census and Statistics

Census of industrial establishments 1945–46. Statistics of factories and productive industries (excluding mining and quarrying) in the Union (twenty-ninth industrial census) ... Pretoria, 1949. xii, 151 pp. 12¾″. 18*s*.

Population census 7th May, 1946. Volume I. Geographical distribution of the population of the Union of South Africa ... Pretoria, 1949. iv, 105 pp. map. 12″. 7*s*. 6*d*.

United Nations

Department of Economic Affairs

The economic development of Latin America and its principal problems; Economic Commission for Latin America. (1950, II, G.2.) Lake Success, 1950. (London, H.M.S.O.) iii, 59 pp.

Economic survey of Asia and the Far East, 1949, prepared by the Secretariat of the Economic Commission for Asia and the Far East. (1950, II, F.1.) Lake Success, 1950. (London, H.M.S.O.) xix, 485 pp. 9″. 22*s*. 6*d*.

International Conference relating to Economic Statistics, Geneva, 26 November–14 December, 1928. International Convention relating to Economic Statistics, amended by the Protocol signed at Paris, 9 December, 1948 ... (1950, XVII, 1). Lake Success, 1950. (London, H.M.S.O.) 14 pp. 13″. 1*s*.

Statistical Office. National income statistics of various countries, 1938–1948. (1950, XVII, 2.) Lake Success, 1950. (London, H.M.S.O.) vii, 249 pp. 11″. 17*s*. 6*d*. paper, 25*s*. cloth.

World Health Organization

Expert Committee on Health Statistics, report on the first session. (Technical Report Series, 5.) Geneva, 1950. (London, H.M.S.O.) 10 pp. 9½″. 9*d*.

II.—AUTHORS AND MISCELLANEOUS

ANSCOMBE (FRANCIS JOHN). Large-sample theory of sequential estimation. *Biometrika*, **36** (1949), 455–458. 10¾″.

—— Note on a problem in probit analysis. *Ann. Appl. Biol.*, **36** (1949), 203–205. 10″.

—— The statistical analysis of insect counts based on the negative binomial distribution. *Biometrics*, **5** (1949), 165–173. 9¼″. (Presented by the author.)

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BRANSBY (ERNEST ROY) and LINDLEY (DENNIS VICTOR). Mortality during 1st world war and during and after the 2nd world war. *Mon. Bull. Ministry Health* (1950), 2–12.

BROWNLEE (KENNETH ALEXANDER). A plant-scale planned experiment in penicillin production. *Ann. N.Y. Acad. Sci.*, **52** (1950), 820–826. 9¼″. (Presented by the author.)

BURN (J. H.), FINNEY (D. J.) and GOODWIN (L. G.). Biological standardization ... 2nd ed. (Oxford Medical Publications.) London, Geoffrey Cumberlege, 1950. x, 440 pp. 8½″. 35*s.*

BURNS (ARTHUR F.). New facts on business cycles ... New York, National Bureau of Economic Research, 1950. vi, 83 pp. 9″.

BURTON (J. H.). Mechanizing for control ... London, Gee & Co., 1950. 95 pp. 8½″. 10*s.* 6*d.*

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REGISTRATION OF THE UNITED KINGDOM

No. I.—ENGLAND AND WALES

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1945–1949 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age; rate per* 1,000 *related Live Births. Stillbirths per* 1,000 *births.)*

Years	1945		1946		1947		1948		1949†	
Estimated Mid-year Popln. in thousands ‡	42,636		42,700		43,050		43,502		43,785	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	685,273	*16·1*	819,894	*19·2*	886,820	*20·6*	776,971	*17·9*	731,568	*16·7*
Stillbirths	19,452	*28*	22,915	*27*	21,916	*24*	18,469	*23*	16,895	*23*
Deaths[1]	488,108	*11·4*	492,090	*11·5*	517,615	*12·0*	469,898	*10·8*	510,819	*11·7*
Marriages	397,626	*9·3*	385,606	*9·0*	401,210	*9·3*	396,891	*9·1*	373,132	*8·5*
Infant Mortality	31,959	*46*	33,548	*43*	36,849	*41*	26,766	*34*	23,682	*32*
Effective reproductive rate[2]	*0·909*		*1·103*		*1·205*				*1·020*	
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	177,946	*16·9*	181,220	*17·2*	241,530	*22·8*	202,01[illegible]	*18·7*	186,561	*17·3*
Apr.–June	175,221	*16·5*	203,808	*19·1*	235,196	*21·9*	203,593	*1[illegible]·8*	192,166	*17·6*
July–Sept.	167,807	*15·6*	213,051	*19·8*	216,508	*20·0*	191,858	*[illegible]*	183,278	*16·6*
Oct.–Dec.	164,299	*15·3*	221,815	*20·6*	193,586	*17·8*	179,473	*16·1*	169,563	*15·4*
	Stillbirths									
Jan.–Mar.	5,190	*28*	5,202	*28*	6,347	*26*	5,045	*24*	4,418	*23*
Apr.–June	4,853	*27*	5,767	*28*	5,831	*24*	4,746	*23*	4,470	*23*
July–Sept.	4,676	*27*	5,831	*27*	5,073	*23*	4,447	*23*	4,104	*22*
Oct.–Dec.	4,733	*28*	6,115	*27*	4,665	*24*	4,231	*23*	3,903	*23*
	Deaths[1] (excluding Stillbirths)									
Jan.–Mar.	157,743	*15·0*	155,227	*14·7*	181,736	*17·1*	132,628	*12·3*	161,279	*14·9*
Apr.–June	110,972	*10·4*	113,908	*10·7*	118,015	*11·0*	110,257	*10·2*	119,984	*11·0*
July–Sept.	97,157	*9·0*	100,409	*9·3*	97,099	*8·9*	101,548	*9·3*	101,207	*9·2*
Oct.–Dec.	122,236	*11·4*	122,546	*11·4*	120,765	*11·1*	125,465	*11·5*	128,349	*11·6*
	Marriages									
Jan.–Mar.	76,975	*7·3*	78,237	*7·4*	75,241	*7·1*	95,443	*8·8*	81,433	*7·5*
Apr.–June	99,709	*9·4*	101,213	*9·5*	109,146	*10·2*	92,822	*8·6*	95,026	*8·7*
July–Sept.	119,447	*11·1*	109,750	*10·2*	119,426	*11·0*	123,157	*11·2*	113,695	*10·3*
Oct.–Dec.	101,495	*9·5*	96,406	*9·0*	97,397	*9·0*	85,469	*7·8*	82,978	*7·5*
	Infant Mortality									
Jan.–Mar.	10,676	*60*	9,637	*56*	12,561	*55*	8,387	*41*	7,462	*40*
Apr.–June	7,227	*41*	7,657	*40*	9,195	*40*	6,357	*31*	5,694	*30*
July–Sept.	6,429	*37*	7,100	*35*	7,141	*32*	5,514	*28*	4,883	*26*
Oct.–Dec.	7,627	*45*	9,154	*43*	7,952	*38*	6,508	*35*	5,643	*32*

* All rates are based on the estimated population as at the middle of the corresponding year.
† Provisional figures.
‡ Inclusive of non-civilians of England and Wales temporarily abroad; and exclusive of non-civilians of Foreign Countries, Dominions, etc., temporarily in England and Wales.
[1] Including deaths of non-civilians registered in England and Wales.
[2] Based not upon current, but upon estimated future mortality.

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No. II.—SCOTLAND

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1945–1949, *and in the Quarters of those years. Numbers, Annual and Quarterly Rates, per* 1,000 *persons living.* (Deaths under* 1 *year of age, rate per* 1,000 *Live Births; Stillbirths per* 1,000 *Births.)*

Years	1945		1946		1947†		1948†		1949†	
Estimated Popln. in thousands‡	4,674		4,901		5,139		5,169		5,175	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	86,932	*16·9*	104,413	*20·3*	113,147	*22·0*	100,344	*19·4*	95,673	*18·5*
Stillbirths	2,949	*33*	3,483	*32*	3,563	*31*	2,966	*29*	2,662	*27*
Deaths	62,655	*13·2*	64,605	*13·1*	66,200	*12·9*	60,979	*11·8*	63,488	*12·3*
Marriages	48,642	*9·4*	45,785	*8·9*	44,411	*8·6*	43,747	*8·5*	41,714	*8·1*
Infant Mortality	4,889	*56*	5,621	*54*	6,309	*56*	4,486	*45*	3,959	*41*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	21,644	*16·9*	22,910	*18·1*	30,479	*24·1*	25,324	*19·8*	24,230	*19·0*
Apr.–June	22,579	*17·6*	25,851	*20·2*	30,366	*23·7*	26,561	*20·7*	25,423	*19·7*
July–Sept.	21,344	*16·4*	27,033	*20·9*	27,028	*20·8*	24,389	*18·7*	23,324	*17·9*
Oct.–Dec.	21,365	*16·5*	28,619	*22·1*	25,274	*19·5*	24,070	*18·5*	22,696	*17·4*
	Stillbirths									
Jan.–Mar.	746	*33*	810	*34*	1,020	*32*	760	*29*	707	*28*
Apr.–June	774	*33*	864	*32*	911	*29*	775	*28*	708	*27*
July–Sept.	671	*30*	854	*31*	853	*31*	711	*28*	640	*27*
Oct.–Dec.	758	*34*	955	*32*	779	*30*	720	*29*	607	*26*
	Deaths (excluding Stillbirths)									
Jan.–Mar.	18,674	*16·0*	19,741	*16·3*	21,198	*16·8*	16,825	*13·1*	19,222	*15·1*
Apr.–June	15,364	*13·0*	15,185	*12·2*	15,653	*12·2*	14,698	*11·4*	15,274	*11·8*
July–Sept.	13,082	*10·9*	13,594	*10·8*	13,447	*10·4*	13,652	*10·5*	13,119	*10·1*
Oct.–Dec.	15,535	*12·9*	16,085	*12·7*	15,902	*12·3*	15,804	*12·2*	15,873	*12·2*
	Marriages									
Jan.–Mar.	9,747	*7·6*	9,971	*7·9*	9,508	*7·5*	9,966	*7·8*	10,638	*8·4*
Apr.–June	12,362	*9·6*	11,466	*9·0*	11,254	*8·8*	10,497	*8·2*	9,209	*7·1*
July–Sept.	13,622	*10·5*	12,839	*9·9*	12,762	*9·8*	13,518	*10·4*	12,789	*9·8*
Oct.–Dec.	12,911	*10·0*	11,509	*8·9*	10,887	*8·4*	9,766	*7·5*	9,078	*7·0*
	Infant Mortality									
Jan.–Mar.	1,465	*68*	1,579	*69*	1,915	*63*	1,303	*51*	1,224	*51*
Apr.–June	1,234	*55*	1,221	*47*	1,609	*53*	1,144	*43*	913	*36*
July–Sept.	979	*46*	1,222	*45*	1,353	*50*	972	*40*	822	*35*
Oct.–Dec.	1,211	*57*	1,599	*56*	1,432	*57*	1,067	*44*	1,000	*44*

* Death rates for 1945 and 1946 are based on civilian deaths and civilian population; from 1947 they are based on all deaths registered in Scotland, and on total population. Birth and marriage rates are based on total population (including persons in the Services).

† Provisional figures.

‡ 1945 and 1946 = Mean of four quarterly estimates of the civilian population.
1947–49 = Estimated mid-year total population.

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No. III.—NORTHERN IRELAND

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1945–1949 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age; rate per* 1,000 *Live Births.)*

Years	1945		1946		1947		1948[3]		1949[3]	
Estimated Mid-Year Popln. in thousands‡	1,317		1,333		1,339		1,351		1,360	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	29,007	*22·0*	30,134	*22·6*	31,254	*23·3*	29,532	*21·9*	29,106	*21·4*
Stillbirths[1]			Not registered							
Deaths	16,264	*12·3*	16,666	*12·5*	16,913	*12·6*	15,125	*11·2*	15,652	*11·5*
Marriages	10,452	*7·9*	9,801	*7·4*	9,517	*7·1*	9,360	*6·9*	9,216	*6·8*
Infant Mortality	1,975	*68*	1,626	*54*	1,658	*53*	1,347	*46*	1,317	*45*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	7,332	*22·2*	7,278	*21·8*	8,318	*24·9*	7,412	*22·1*	7,379	*21·8*
Apr.–June	7,509	*22·8*	7,924	*23·8*	8,539	*25·5*	8,030	*23·9*	7,764	*22·9*
July–Sept.	7,188	*21·8*	7,646	*22·9*	7,516	*22·4*	7,262	*21·5*	7,193	*21·2*
Oct.–Dec.	6,978	*21·1*	7,286	*21·9*	6,881	*20·5*	6,828	*20·2*	6,770	*19·9*
	Deaths‡ (excluding Stillbirths)									
Jan.–Mar.	5,249	*15·9*	5,435	*16·3*	5,902	*17·7*	4,313	*12·8*	4,758	*14·0*
Apr.–June	3,962	*12·0*	4,026	*12·1*	4,011	*12·0*	3,817	*11·4*	3,812	*11·2*
July–Sept.	3,339	*10·1*	3,280	*9·8*	3,276	*9·8*	3,323	*9·9*	3,228	*9·5*
Oct.–Dec.	3,714	*11·3*	3,925	*11·8*	3,724	*11·1*	3,672	*10·9*	3,854	*11·3*
	Marriages									
Jan.–Mar.	2,140	*6·5*	2,224	*6·7*	1,820	*5·5*	2,150	*6·4*	1,975	*5·8*
Apr.–June	2,806	*8·5*	2,509	*7·5*	2,517	*7·5*	2,158	*6·4*	2,287	*6·7*
July–Sept.	2,984	*9·0*	2,840	*8·5*	2,905	*8·6*	2,972	*8·8*	2,862	*8·4*
Oct.–Dec.	2,522	*7·6*	2,228	*6·7*	2,275	*6·8*	2,080	*6·2*	2,092	*6·1*
	Infant Mortality[2]									
Jan.–Mar.	700	*95*	464	*64*	497	*60*	395	*53*	402	*55*
Apr.–June	504	*67*	436	*55*	442	*52*	352	*44*	297	*38*
July–Sept.	384	*53*	331	*43*	314	*42*	302	*41*	309	*43*
Oct.–Dec.	382	*55*	388	*53*	405	*59*	298	*44*	309	*46*

* Rates are based on Civilian population only.

‡ Civilians only.

[1] Stillbirths are not registered in Northern Ireland. The birth of one living child and one stillborn, or one living child and two stillborn, is counted as one birth.

[2] The annual figures have been corrected, so that slight differences appear between them and the aggregates of the quarterly figures.

[3] By courtesy of the Registrar-General for Northern Ireland.

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No. IV.—EIRE

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1945–1949 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age, rate per* 1,000 *Live Births.)*

Years	1945		1946		1947		1948(†)		1949(†)	
Estimated Mid-year Popln. in thousands	2,952		2,963		2,972		2,997		2,991	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	66,861	*22·6*	67,922	*22·9*	68,978	*23·2*	65,584	*21·9*	63,954	*21·4*
Stillbirths‡			Not registered							
Deaths	42,762	*14·5*	41,457	*14·0*	44,061	*14·8*	36,502	*12·2*	38,098	*12·7*
Marriages	17,301	*5·9*	17,525	*5·9*	16,290	*5·5*	16,331	*5·4*	16,299	*5·4*
Infant Mortality ..	4,739	*71*	4,390	*65*	4,687	*68*	3,212	*49*	3,292	*51*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	16,073	*21·8*	17,005	*23·0*	17,537	*23·6*	16,177	*21·6*	16,329	*21·9*
Apr.–June	17,940	*24·3*	18,122	*24·5*	18,946	*25·5*	18,006	*24·0*	16,605	*22·2*
July–Sept.	17,244	*23·4*	17,230	*23·3*	17,424	*23·5*	16,410	*21·9*	16,490	*22·1*
Oct.–Dec.	15,604	*21·1*	15,565	*21·0*	15,071	*20·3*	14,991	*20·0*	14,530	*19·4*
	Deaths (excluding Stillbirths)									
Jan.–Mar.	13,715	*18·6*	13,042	*17·6*	15,975	*21·5*	10,653	*14·2*	11,018	*14·7*
Apr.–June	10,754	*14·6*	10,515	*14·2*	11,161	*15·0*	9,419	*12·6*	9,918	*13·3*
July–Sept.	8,892	*12·0*	8,539	*11·5*	8,288	*11·2*	7,886	*10·5*	8,107	*10·8*
Oct.–Dec.	9,401	*12·7*	9,361	*12·6*	8,637	*11·6*	8,544	*11·4*	9,055	*12·1*
	Marriages									
Jan.–Mar.	3,697	*5·0*	4,478	*6·0*	3,769	*5·1*	3,673	*4·9*	3,814	*5·1*
Apr.–June	4,594	*6·2*	4,147	*5·6*	4,023	*5·4*	4,058	*5·4*	3,594	*4·8*
July–Sept.	4,928	*6·7*	5,161	*7·0*	4,899	*6·6*	4,963	*6·6*	5,280	*7·1*
Oct.–Dec.	4,082	*5·5*	3,739	*5·0*	3,599	*4·8*	3,637	*4·9*	3,611	*4·8*
	Infant Mortality									
Jan.–Mar.	1,486	*92*	1,408	*83*	1,639	*93*	1,027	*63*	895	*55*
Apr.–June	1,097	*61*	1,051	*58*	1,241	*66*	831	*46*	825	*50*
July–Sept.	1,032	*60*	948	*55*	832	*48*	629	*38*	722	*44*
Oct.–Dec.	1,124	*72*	983	*63*	975	*65*	725	*48*	850	*58*

* Rates are based on the total estimated population as at the middle of the corresponding year.
† Provisional figures.
‡ Stillbirths are not registered in Eire. The births of one living child and one stillborn, or of one living child and two stillborn, are counted as one birth.

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